UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

MEMORANDUM

January 23, 2001

SUBJECT: Drinking water exposure assessment for atrazine and various chloro-triazine and hydroxy-triazine degradates

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1. Introduction

This is a drinking water exposure assessment for atrazine and its various chloro-triazine and hydoxy-triazine degradates. The conclusions and summary of results are in Section 10. The recommendations of the Environmental Fate and Effects Division (EFED) of the Office of Pesticide Programs (OPP) for mitigation of drinking water contamination will later be included in a separate document.

1.1) Documents and data

A list of references is included in the last section (Section 11).

The drinking water exposure assessment of atrazine in Community Water Supplies (CWSs) is based primarily on a statistical analysis of the Novartis Population Linked Exposure (PLEX) database (references 1-3; see Section 4). The database includes atrazine concentrations in thousands of CWSs in 21 major atrazine use states over the 1993-1998 period, and also includes the populations served by the CWSs. The CWSs with data in the PLEX database include those with ground water, surface water, and combination (blend) of ground and surface water sources. The data were collected by CWSs to comply with the monitoring requirements of the Safe Drinking Water Act (SDWA)

The exposure assessment of atrazine and its chloro- and hydroxy-triazine degradates in non-CWS rural well ground water is based upon a statistical analysis of results from the Novartis/States Rural Well Survey (reference 4; see Section 5).

In addition, data on atrazine concentrations in surface water source CWSs from the Novartis Voluntary Monitoring Study (VMS) (references 5 and 6) and the Acetochlor Registration Partnership (ARP) Surface Water Monitoring Study (references 7, 8, and 9) were statistically analyzed (See Sections 6 and 7, respectively). Those studies on surface water source CWSs include less than 100 and 175 CWSs, respectively, compared to the thousands of CWSs included in the PLEX database. However, the VMS and ARP studies provide far more time series data per CWS than the Novartis PLEX database which has just one data point per quarter per CWS.

Data on atrazine concentrations in 177 wells from the ARP Monitoring Study were also statistically analyzed (reference 10; see Section 8).

Limited data on the concentrations of chloro-triazine degradates in surface water source CWSs (reference 11) were used to develop regression equations relating the sum of chloro-triazine degradate (DEA, DIA, and DACT) concentrations to atrazine concentrations (see Section 3.1). The regression equations were applied to other PLEX, VMS, and ARP data on atrazine concentrations in surface water source CWSs to estimate the sum of atrazine and its major chloro-triazine degradate concentrations (see Section 3.1).

Additional data on atrazine concentrations in OH CWSs (reference 12), in IL CWSs (reference 13), in TX CWSs (reference 14), and in CWSs in several states (reference 15) are also briefly discussed (see Section 9).

1.2) Data gaps

Data gaps for atrazine and its degradates in drinking water include:

(1) There are only limited data on the concentrations of chloro-triazine degradates in surface water source drinking water (reference 11). The limited available data were used to develop regression equations for estimating total chloro-triazine degradate concentrations from atrazine concentrations in surface water source CWSs. However, additional independent data on chloro-triazine degradates in

surface water source CWSs are needed to determine the accuracy of the regression estimates.

(2) The EFED is unaware of any data available on the concentrations of hydroxy-triazine degradates in surface water source CWSs. As indicated in Section 2.2 on environmental fate, hydroxy-triazine degradates other than possibly hydroxy-atrazine (HA) are unlikely to significantly contaminate surface water. As also indicated in Section 2.2, HA is generally unlikely to contaminate surface water to the same degree as atrazine and some of the chloro-triazine degradates. However, some occasionally significant contamination of surface water by HA cannot be ruled out by the EFED without at least some screening data.

(3) There are data available on the concentrations of chloro-triazine and hydroxy-triazine degradates in rural wells (MRID 439344-14, reference 4), but comparable types of data are currently not available for ground water source CWSs. Novartis has recently completed a stratified random sampling of ground water source CWSs to determine degradate concentrations. However, the data are not yet available to the EFED and therefore cannot be included in this assessment. The EFED will analyze the data when it becomes available, and include it later in a revised drinking water exposure assessment.

1.3) Uncertainties in the drinking water exposure assessment and caveats on its use

(1) This current drinking water exposure assessment for atrazine and its degradates is incomplete due to the degradate data gaps discussed in Section 1.2.

(2) All of the monitoring studies/databases referred to in this assessment have varying degrees of bias (generally conservative) in the selection of CWSs and/or wells for sampling. Therefore, there will generally be conservative uncertainties associated with any extrapolation of the results of a drinking water exposure/risk assessment based on the data from a given study beyond the populations served by the CWSs and/or private wells sampled within the study. The magnitudes of the uncertainties will depend substantially on the degree of conservative bias in selecting the CWSs and/or wells for sampling.

(3) All of the monitoring studies/databases referred to in this assessment have varying degrees of negative bias due to inadequate sampling frequency to accurately determine atrazine peak concentrations. Observed maximum atrazine concentrations will generally underestimate actual peak atrazine concentrations to a degree substantially dependent upon the frequency of sampling and the rate at which atrazine concentrations change with time. Underestimates of peak atrazine concentrations also result in regression underestimates of peak total chloro-triazine concentrations.

(4) Of the principal studies/databases referred to in this assessment, the Novartis Voluntary Monitoring Study (VMS) of surface water CWSs has the highest conservative bias in the selection of CWSs for sampling. All of the CWSs included in that study had either a history of significant atrazine contamination or were thought to have a relatively high potential for atrazine contamination based upon

atrazine use in the watershed. Except for screening purposes, drinking water exposure/risk assessments based on VMS data should not be extrapolated beyond the populations served by the CWSs sampled in the VMS.

The ARP Monitoring Study probably has the least conservative bias due to the stratified random sampling methodology used to select CWSs and wells for sampling.

(5) Of the studies/databases referred to in this assessment, the Novartis PLEX database and the Novartis/states Rural Well Survey are likely to have the most negative bias due to inadequate sampling frequencies. In the PLEX database, data are generally only available for one sample per quarter per CWS (as is the minimum sampling requirement of the SDWA). In the Rural Well Survey, only one sample was collected per well. Although atrazine concentrations are not likely to change as rapidly over time in ground water as in surface water, there will still obviously be some dependence on time in ground water (See Section 8 on the ARP Ground Water Monitoring study).

The ARP Surface Water Monitoring Study, the VMS, and the ARP Ground Water Monitoring Study have substantially more time series data than the PLEX database (which typically has the results for only one sample per quarter per CWSs). Therefore, observed maximum atrazine concentrations in those studies for a given CWS should generally be closer to actual peak atrazine concentrations in the CWS than observed maximum atrazine concentrations for the same CWS in the PLEX database.

(6) The sum of atrazine and chloro-triazine degradate (DEA, DIA, and DACT) concentrations are referred to in this document as total chloro-triazine concentrations. However, the sum does not include the concentrations of cyanazine, simazine, and propazine or any chloro-triazine degradates of those chemicals that are not in common with the chloro-triazine degradates of atrazine. Therefore, total chloro-triazine concentrations in some CWSs and/or wells may be somewhat greater than indicated by the sum of atrazine and its chloro-triazine degradates.

Cyanazine was not included in this assessment because all of its use in the U.S. will be phased out by the end of 2002. Propazine was not included in this assessment because the EFED does not currently have any data on propazine in drinking water. The primary use of propazine is on sorghum which is grown primarily in Kansas, Nebraska, and Texas. However, the National Agriculture Statistics Service indicates that the use of propazine on sorghum is small compared to a number of other herbicides including atrazine. Therefore, the contribution of propazine to total chloro-triazines is likely to be small compared to atrazine in most areas, including where sorghum is grown.

Simazine was not included in computing total chloro-triazines for this assessment because the OPP's Health Evaluation Division (HED) is still reviewing mammalian toxicity data for simazine. Therefore, no decision has yet been made by the HED on whether simazine's mode of action or magnitude of effect with respect to mammalian toxicity is similar enough to those of atrazine, DEA, DIA, and DACT to include it in computing total chloro-triazines for comparison to HED acute and sub-chronic/chronic

Drinking Water Levels of Concern (DWLOCs) for total chloro-triazines.

Depending upon the results of the toxicity review by the HED, a revised drinking water exposure assessment by the EFED may include simazine in computing total chloro-triazines for comparison to the current DWLOCs for total chloro-triazines, include simazine in computing total chloro-triazines for comparison to simazine modified DWLOCs for total chloro-triazines, or compare simazine separately or in conjunction with other chemicals with similar modes of action to a completely different set of DWLOCs.

A comparison of simazine and atrazine data in the Novartis PLEX database for thousands of CWSs in 21 atrazine and simazine "major use" states indicates that in areas with substantial sums of atrazine and simazine concentrations such as in the midwestern corn belt, simazine contributions to the sum are generally small compared to the contributions of atrazine. In orchard areas of California and Florida where simazine contributions to the sum are sometimes greater than atrazine contributions, the sum of atrazine and simazine concentrations is generally much smaller than in the mid-western corn belt.

(7) The regression equations the EFED used to estimate the sum of three chloro-triazine atrazine degradate (DEA + DIA + DACT) concentrations from atrazine concentrations were developed from limited data on chloro-triazine and corresponding atrazine concentrations in 17 surface water CWSs. There is considerable data scatter around each regression line, r^2 values of 0.48 to 0.71 are marginal, 95% confidence intervals around the slopes and intercepts are relatively wide, and the number of low atrazine concentrations used in developing the regression equations is much greater than the number of intermediate to high atrazine concentrations. Another source of uncertainty in the regression equations is that they were developed by regressing the sum of the chloro-triazine degradate concentrations against just the atrazine concentration even though some of the degradates are also degradates of cyanazine and/or simazine. As indicated in data gap Section 1.2, additional independent data on chloro-triazine degradates in surface water source CWSs are needed to determine the accuracy of the regression estimates.

2. Atrazine Use and Environmental Fate

2.1 Summary of Atrazine Use

A national map of atrazine use per unit area is provided in Figure 2-1. The map was downloaded from a U.S. Geological Survey (USGS), National Water Quality Assessment Program (NAWQA) website. The map is based upon the 1992 Census of Agriculture. The heaviest atrazine uses per unit area (those of > 66 lbs ai/sq mi of county/yr) occur in large portions of DE, IA, IL, IN, OH, and NE and in smaller portions of FL, KS, KY, LA, MD, MI, MN, MO, PA, TN, TX, and WI.

Of the approximately 76.5 million pounds of atrazine applied within the U.S. and analyzed in 1999, 83.4%, 10.2%, and 3.3% were applied to corn, sorghum, and sugar cane, respectively [Biological and Economic Analysis Division (BEAD)/OPP, 1999].

2.2 Summary of Atrazine Fate and Transport

Atrazine can contaminate nearby non-target plants, soil and surface water via spray drift during application. Atrazine is applied directly to target plants during foliar application, but pre-plant and pre-emergent applications are generally far more prevalent.

The resistence of atrazine to abiotic hydrolysis (stable at pHs 5, 7, and 9) and to direct aqueous photolysis (stable under sunlight), and its only moderate susceptibility to degradation in soil (aerobic laboratory half-lives of 3-4 months) indicate that atrazine is unlikely to undergo rapid degradation on foliage. Likewise, a relatively low Henry's Law constant (2.6 X 10^{-9} atm$\cdot$m^3/mol) indicates that atrazine will probably not undergo rapid volatilization from foliage. However, its relatively low octanol/water partition coefficient (Log K_{ow} = 2 .7), and its relatively low soil/water partitioning (Freundlich K_{ads} values < 3 and often < 1) may somewhat offset the low Henry's Law constant value thereby possibly resulting in some volatilization from foliage. In addition, its relatively low adsorption characteristics indicates that atrazine may undergo substantial washoff from foliage. It should also be noted that foliar dissipation rates for numerous pesticides have generally been somewhat greater than otherwise indicated by their physical chemical and other fate properties.

Atrazine is applied directly to soil during pre-planting and/or pre-emergence applications. Atrazine is transported indirectly to soil due to incomplete interception during foliar application, and due to washoff subsequent to foliar application. The available data indicates that atrazine is only moderately susceptible to degradation in soil under aerobic conditions with reported half-lives between 3 and 4 months in several aerobic soil laboratory studies. In an anaerobic aquatic study, atrazine half-lives were much longer with the overall, water, and sediment half-lives being 608, 578, and 330 days, respectively.

Deethyl-atrazine (DEA; G-30033), deisopropyl-atrazine (DIA; G-28279), and hydroxy-atrazine (HA; G-34048) were detected in all of the studies, and diaminochloro-triazine (DACT; G-28273) was detected in all but one of the laboratory metabolism studies. Deethylhydoxy-atrazine (DEHA; GS-17794) and deisopropylhydroxy-atrazine (DIHA; GS-17792) were also detected in one of the aerobic studies. All of the chloro-triazine and hydroxy-triazine degradates detected in the laboratory metabolism studies were present at much less than the 10% of applied that the EFED uses to classify degradates as "major degradates".

For studies limited to several months, the relative concentrations of the degradates in soil were generally DEA>DIA>DACT~HA. However, for an aerobic soil metabolism study and an anaerobic aquatic metabolism study both lasting a year, the concentration of HA was comparable to that of DEA over the last few months of the studies. In addition, some literature indicates that higher quantities of HA can be formed in soil and in sediment under acidic conditions. Other hydroxy-triazine degradates have only rarely be detected in lab studies.

The structures of atrazine, DEA, DIA, DACT, HA, DEHA, DIHA, and diaminohydroxy-atrazine (DAHA) are provided in Figure 2-2 from Novartis (reference 4). Note that DIA and DACT are also degradates of simazine. In addition, DACT is also a degradate of cyanazine.

The soil/water partitioning of atrazine, DEA, DIA, and DACT are relatively low as shown by Freundlich adsorption coefficients of < 3 and often < 1 for 4 different soils. The Freundlich adsorption constants for HA are substantially greater, being approximately 2 for sand, but 6.5, 12.1, and 390 for a sandy loam, loam, and clay soil, respectively. No adsorption/desorption data are available for other hydroxy-triazine degradates. However, the higher soil/water partitioning exhibited by HA compared to atrazine suggests that the other hydoxy-triazines are likely to exhibit higher soil/water partitioning than corresponding chloro-triazine degradates.

In a limited study on atrazine and its chloro-degradates in surface water source CWSs, the detection of all was relatively widespread. However, atrazine predominated with the relative order of concentrations generally being atrazine >>DEA>DIA~DACT.

In the Rural Well Survey (which also included four hydroxy-triazine degradates as analytes), the four hydroxy-triazine degradate analytes were all detected. Of the hydroxy-triazine degradates, hydroxy-atrazine was detected the most frequently and generally at the highest level, but not to the same extent as atrazine or the chloro-triazine degradates. The percentages of detection above a LOD of 0.1 ug/L in the Rural Well Survey for atrazine, DEA, DIA, DACT, HA, DEHA, DIHA, and DAHA were 26.8%, 32.0%, 16.7%, 25.9%, 6.11%, 2.99%, 0.27%, and 0.33%, respectively. Unlike in the surface water study on degradates where atrazine concentrations were generally much greater than chloro-triazine degradate concentrations, the DEA, and DACT chloro-triazine degradate concentrations in the Rural Well Survey were often comparable to those of atrazine. The relative order of concentrations in the Rural Well Survey was generally atrazine~DEA~DACT>DIA>HA .

The relatively widespread detection of atrazine and various chloro-triazine degradates in the surface water study on degradates and in the Rural Well Survey is consistent with the widespread use of atrazine, the persistence of atrazine and the mobility of atrazine and its chloro-triazine degradates. The lower frequency of detection and generally lower levels of the HA in the Rural Well Survey is consistent with its higher soil/water partitioning than atrazine and the chloro-triazine degradates.

The available fate and ground water data indicate that hydoxy-triazine degradates other than possibly HA are unlikely to significantly contaminate surface water. They are not appreciably formed in soil, and they are likely to exhibit higher soil/water partitioning than corresponding chloro-triazine degradates. In addition, they were detected much less frequently and at much lower levels than hydroxy-atrazine in the Rural Well Survey.

The substantially higher soil/water partitioning and generally slower rate of formation in soil exhibited by HA compared to atrazine and some of the chloro-triazine degradates indicate that it is likely to have a lower potential for surface water contamination. However, HA was detected in 6.1% of the samples in the Rural Well Survey at concentrations up to 6.5 ug/L. Also, there have been reported concentrations of HA in soil sometimes approaching and possibly in some cases (e.g., acidic soils) exceeding that of DEA. Therefore, occasional significant contamination of surface water by HA cannot be ruled out by the EFED without at least some screening data.

Atrazine should be somewhat persistent in ground water and in surface waters with relatively long hydrologic residence times (such as in some reservoirs) where advective transport is limited. The reasons for this are the resistence of atrazine to abiotic hydrolysis and to direct aqueous photolysis, its only moderate susceptibility to biodegradation, and its limited volatilization potential as indicated by a relatively low Henry's Law constant. As will be discussed later, atrazine has been observed to remain at elevated concentrations longer in some reservoirs than in flowing surface water or in other reservoirs with presumably much shorter hydrologic residence times in which advective transport greatly limits its persistence.

The relatively low soil/water partitioning of atrazine and chloro-triazine degradates indicates that their concentrations in/on suspended and bottom sediment in equilibrium with the water column will be somewhat comparable. However, despite relatively low soil/water partitioning, limited data indicated that activated carbon can be effective in reducing atrazine and its triazine degradate concentrations by several fold to over an order of magnitude depending upon the frequency and conditions of its use.

Atrazine has been widely detected in rainfall. A USGS study (reference 16) showed that the highest concentrations of atrazine occur in the high use, midwestern corn belt during the application season (mid-April through mid- July). Volume-weighted concentrations ranging from 0.2 to 0.9 : gL^{-1} were reported in the late spring and summer of 1990 and 1991. In addition, the chloro-degradates DEA and

DIA were also detected in rainfall together with atrazine. Moreover, high ratios of DEA to atrazine (approximately 0.5) were attributed to atmospheric degradation. Mass deposition of atrazine and degradates have been found to be higher in the midwestern corn belt, but to decrease with distance away from the corn belt. The USGS study estimated that approximately 0.6% of applied atrazine was annually deposited in rainfall over the study area.

Figure 2-1. USGS's Estimated Atrazine Annual Agricultural Use

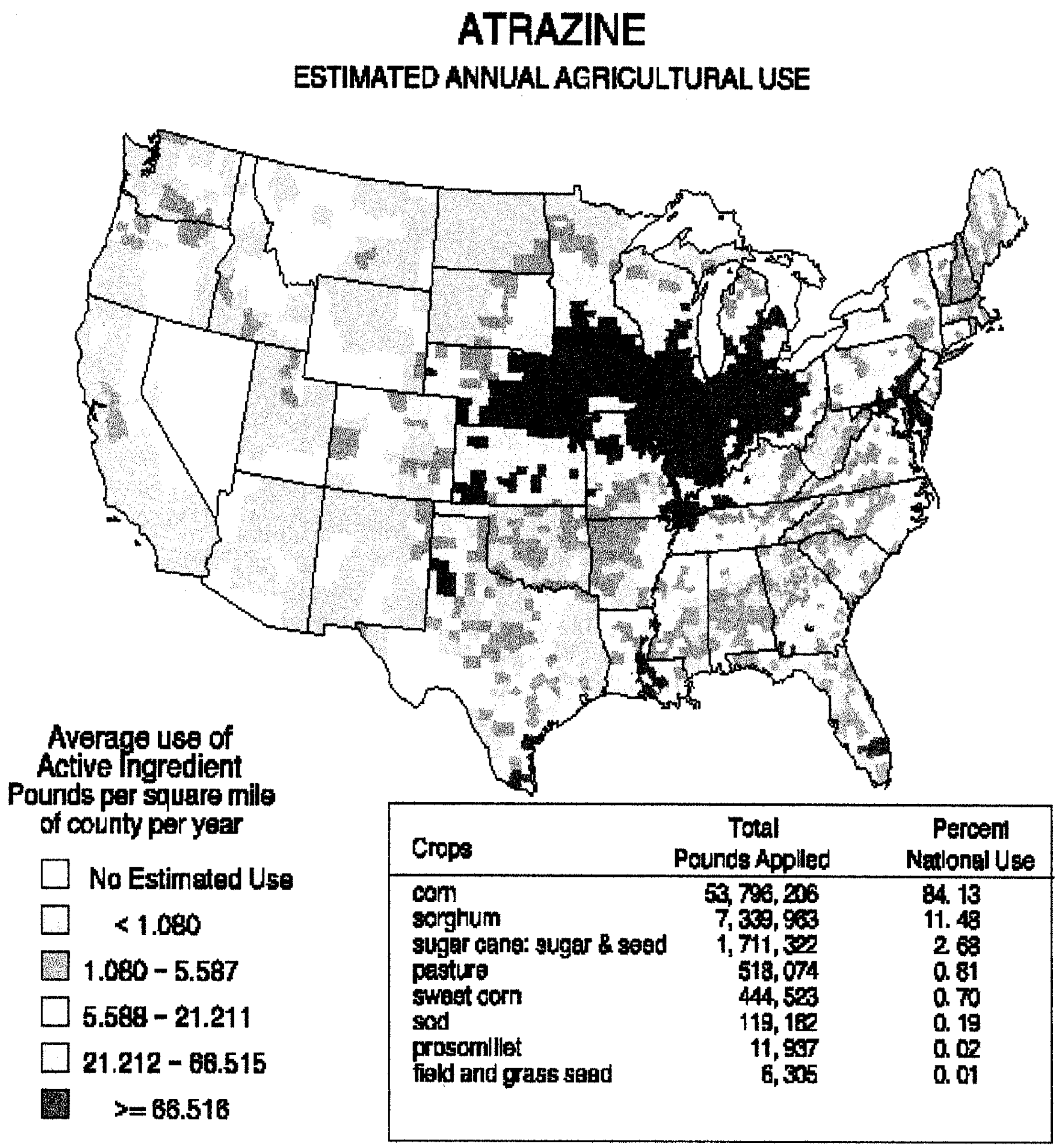
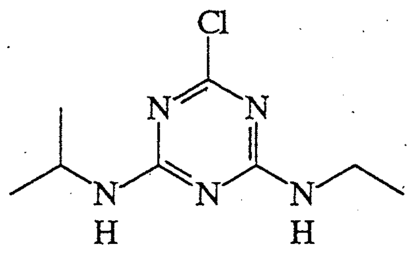
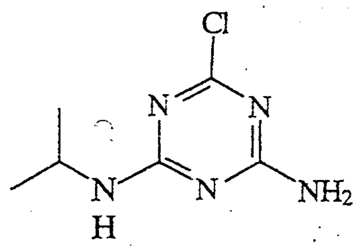


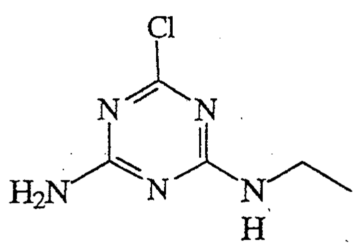
Figure 2-2. Chemical Structure - Atrazine and its chloro and hydroxy degradation products



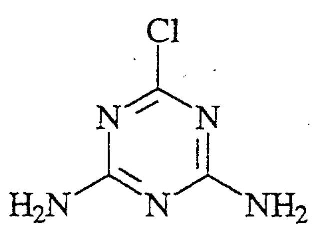
Atrazine



G-30033 (Deethylatrazine)

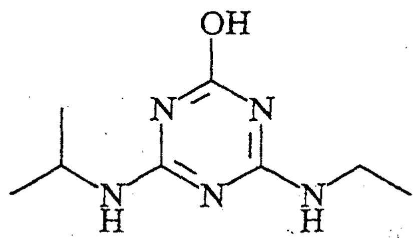


G-28279
(Deisopropylatrazine)

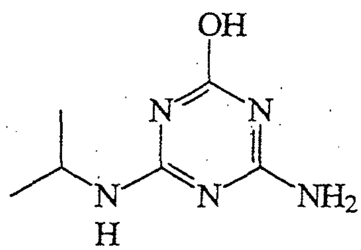


G-28273
(Diaminochlorotriazine)

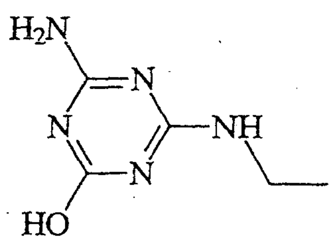
Figure 2-2. **Chemical Structure - Atrazine and its chloro and hydroxy degradation products (continued)**



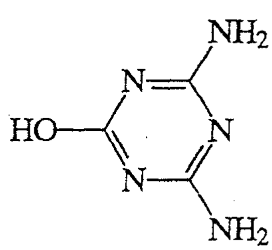
G-34048 (Hydroxyatrazine)



GS-17794
(Deethylhydroxyatrazine)



GS-17792
(Deisopropylhydroxyatrazine)



GS-17791
(Diaminohydroxyatrazine)

3. Assessment Methodologies

3.1) Development and application of regression equations for estimating total chloro-triazine degradate concentrations in surface water source CWSs from atrazine concentrations

The PLEX database of atrazine concentrations in CWSs in 21 states does not currently have any data on chloro-triazine or on hydroxy-triazine degradates. However, the EFED and Novartis have recently independently developed (from Novartis data on 17 surface water source CWSs) regression equations relating the sum of the chloro-triazine degradate (DEA, DIA, and DACT) concentrations in surface water source CWSs to the atrazine concentrations.

From August 1997 through July 1998, Norvatis sampled 20 surface water treatment plants representing 17 CWSs in seven states (Figure 3-1 which is Figure 2 of MRID 450587-03). Samples were collected monthly August through April and twice per month in May, June, and July. The samples were analyzed for atrazine, deethyl-atrazine (DEA), deisopropyl-atrazine (DIA), and diaminochloro-triazine (DACT) (refer back to Figure 2-2).

The selection criteria for the sampled CWSs included being in an area vulnerable to contamination within a high atrazine use state, and having a history of previous atrazine detection. In addition, CWSs were selected to represent a variety of system sizes, watershed sizes and uses, and source water body sizes.

The EFED linearly regressed the sum of the DEA, DIA, and DACT water concentrations against atrazine concentrations in finished water. The regression graph based on the whole year set of data is provided in Figure 3-2. However, as first proposed by Novartis, regressions were also done separately for each quarter as well as for the whole year to better reflect changes in degradate/parent ratios over time. The regression graphs based on individual quarters of data are provided in Figures 3-3 through 3-6. The resulting regression equations (where y = sum of the DEA, DIA, and DACT degradate finished concentrations and x = atrazine finished concentrations) were as follows:

Whole year : $y = (0.418 \pm 0.044)\,x + (0.240 \pm 0.063)$ (Figure 3-2; $r^2 = 0.541$; n = 291; df = 289)
1st quarter: $y = (0.535 \pm 0.137)x + (0.223 \pm 0.096)$ (Figure 3-3; $r^2 = 0.502$; n = 59; df = 57)
2nd quarter: $y = (0.394 \pm 0.051)x + (0.107 \pm 0.108)$ (Figure 3-4; $r^2 = 0.710$; n = 94; df = 92)
3rd quarter: $y = (0.704 \pm 0.165)x + (0.123 \pm 0.180)$ (Figure 3-5; $r^2 = 0.482$; n = 77; df = 75)
4th quarter: $y = (0.630 \pm 0.137)\,x + (0.122 \pm 0.124)$ (Figure 3-6; $r^2 = 0.582$; n = 61; df = 59)

Numbers following $\pm$ represent 95% confidence intervals on the regression slopes and intercepts, respectively.

Although Novartis also developed separate regression equations for each quarter, they were based upon a pooling of raw with finished water samples. Therefore, the EFED chose to use EFED developed regression equations which are based only upon finished water samples.

To estimate total chloro-triazine degradate concentrations, the EFED applied the 4 quarterly regression equations (each representing a different quarter) to individual atrazine concentrations in surface source CWSs from the Voluntary Monitoring Study and the ARP Surface Water Monitoring Study after the data were separated by quarter. However, due to time constraints on this assessment and the magnitude of data on individual atrazine concentrations in the PLEX database, the EFED used a different procedure to estimate total chloro-triazine degradate concentrations from atrazine concentrations in the surface water portion of the PLEX database. Rather than applying the quarterly regression equations to individual atrazine concentrations, the EFED applied the annually based regression equation to annual maximum atrazine and annual mean atrazine concentrations developed from the surface water portion of the PLEX database.

Once total chloro-triazine degradate concentrations were estimated from regression, total chloro-triazine concentrations were estimated by adding the atrazine concentration. In effect, 1x (representing atrazine) was added to the right side of each regression equation to give estimates of total chloro-triazines rather than total chloro-triazine degradates.

Cumulative exceedence frequency curves for atrazine, DEA, DIA, and DACT based on the whole year set of data are provided in Figure 3-7. The curves are plots of the concentrations versus the % of samples with equal or greater concentrations. For any given exceedence percentile, atrazine was generally much greater than DEA which was greater than either DIA and/or DACT, which were generally comparable (atrazine >>DEA>DIA~DACT).

Cumulative exceedence frequency curves for (atrazine + DEA + DIA + DACT), atrazine, (DEA + DIA + DACT), and (DEA + DIA) based on the whole year set of data are provided in Figure 3-8. For any given exceedence percentile, atrazine was greater than (DEA + DIA + DACT).

3.2) Cumulative exceedence curves and tables

Much of this drinking water exposure assessment is based upon the development of cumulative exceedence curves and corresponding tables by Novartis and by the EFED, and the comparison of them to various levels of concern in drinking water. Cumulative exceedence curves are plots of a given type of exposure concentration against the percentage of the population served by (or the percentage of CWSs, wells, or samples with) an equal or greater concentration. The cumulative exceedence curves in this document were constructed with Weibull plot positions, which assign a probability to each ranked concentration value as the rank divided by the sum of total number of samples plus one. Examples of types of exposure concentrations that can be plotted as cumulative exceedence curves include annual means, annual maximum quarterly means, annual maximums, and individual concentrations for atrazine, total chloro-triazines, or total hydroxy-triazines.

The intersection of a cumulative exceedence curve with one or more horizontal lines representing one or more drinking water levels of concern (DWLOCs) gives the percentage or percentages of the assessed population served by (or the percentage or percentages of CWSs or wells with) an equal or higher concentration than the DWLOC(s). Examples of DWLOCs include acute and sub-chronic/chronic DWLOCs developed by the HED as well as Maximum Contaminant Levels (MCLs) and Health Advisory Levels (HALs) developed by the Office of Drinking Water.

3.3) Examples of cumulative exceedence curves, corresponding tables, and linear interpolation

Examples of cumulative exceedence curves with concentrations in individual samples plotted against the % of samples with equal or greater concentrations were provided in Figures 3-7 and 3-8. Two additional examples of cumulative exceedence curves are provided in Figures 3-9 and 3-10. Both figures use the same annual mean atrazine concentration data. However, in Figure 3-9 the annual mean atrazine concentrations are plotted against the % of CWSs with equal or greater annual mean atrazine concentrations. By contrast in Figure 3-10, the annual mean atrazine concentrations data are plotted against the % of the assessed population served by equal or greater annual mean atrazine concentrations.

The horizontal line drawn in figures 3-9 and 3-10 represents the atrazine MCL of 3 ug/L. The arrow in Figure 3-9 extrapolated from the intersection of the horizontal line (representing the MCL) and the cumulative exceedence curve to the x-axis gives the approximate % of CWSs with annual atrazine means equal to or exceeding the MCL of 3 ug/L (4.5% in this example). Likewise the arrow in Figure 3-10 gives the approximate % of the assessed population served by an annual mean atrazine concentration equal to or greater than the MCL (0.8% in this example).

More accurate estimates of the exceedence percentiles can be made by applying linear interpolation to the corresponding cumulative exceedence tables. For example the % of CWSs with, and the % of population served by, an annual mean atrazine concentration equal to or greater than the MCL of 3 ug/L are estimated by linear interpolation to be 4.73% and 0.73%, respectively.

From concentrations listed in tables associated with each cumulative exceedence curve, the EFED used linear interpolation to estimate concentrations associated with various percentiles of general interest such as the 99th, 95th, 90th, and 75th percentiles (1, 5, 10, and 25th exceedence percentiles). In addition, the EFED used linear interpolation to calculate percentiles and exceedence percentiles associated with various DWLOCs

3.4) Office of Drinking Water MCL/HAL and HED/Office of Pesticide Programs DWLOCs

The Office of Drinking Water has set a Maximum Contaminant Level (MCL) of 3 ug/L and a short term Health Advisory Level (HAL) of 100 ug/L for atrazine. Under the Safe Drinking Water Act (SDWA), CWSs are in non-compliance if any running annual mean atrazine concentration (based on the arithmetic mean of atrazine concentrations in 4 successive quarterly samples) exceeds the MCL. Note that non-compliance is based on annual mean atrazine concentrations rather than on atrazine concentrations in individual samples or shorter than annual atrazine mean concentrations exceeding the MCL.

The HED has set acute and sub-chronic/chronic drinking water levels of concern (DWLOCs) for total chloro-triazines (atrazine + DEA + DIA + DACT) and total hydroxy-triazines as follows, assuming that the intake from food ingestion is negligible.

The HED established a total chloro-triazine acute DWLOC of 298 ug/L for pregnant women. The HED could not establish any total chloro-triazine acute DWLOCs for men, non-pregnant women, children or infants. The HED established total chloro-triazine sub-chronic/chronic DWLOCs of 63, 63, 18, and 18 ug/L for men, women, children, and infants, respectively.

The HED could not establish total hydroxy-triazine acute DWLOCs for any population category. The HED established total hydroxy-triazine chronic DWLOCs of 348, 298, 99, and 99 ug/L for men, women, children, and infants, respectively.

3.5) Comparison of atrazine concentrations to MCLs/HALs and total chloro-triazine and total hydroxy-triazine concentrations to HED DWLOCs

The EFED compared annual mean atrazine and annual maximum atrazine concentrations in surface water to the Office of Drinking Water MCL of 3 ug/L and short term HAL of 100 ug/L for atrazine, respectively. Because each well was only sampled once, individual atrazine concentrations from the Rural Well Survey were compared to both the MCL and the short term HAL.

The EFED compared annual maximum total chloro-triazine concentrations in surface water to the one HED acute DWLOC of 298 for adult females. The EFED compared quarterly and annual mean total chloro-triazine concentrations in surface water to the HED/ sub-chronic/ chronic DWLOCs for total chloro-triazines. Because each well was only sampled once, the EFED compared individual total chloro-triazine concentrations from the Rural Well Survey to both acute and sub-chronic/chronic DWLOCs for total chloro-triazines. There are no monitored total chloro-atrazine concentration data currently available for ground water source CWSs, so no comparison to chloro-triazine DWLOCs could be made for ground water source CWSs.

The HED could not establish any acute DWLOCs for total hydroxy-triazines to which the EFED could compare total hydroxy-atrazine concentrations from the Rural Well Survey. Because each well was only sampled once, the EFED compared total hydroxy-triazine concentrations in individual samples from the Rural Well Survey to the HED/OPP sub-chronic/chronic DWLOCs for total hydroxy-triazines. There are no estimated or monitored total hydroxy-triazine concentrations currently available in surface water or ground water source CWSs, so no comparison to hydroxy-triazine DWLOCs could be made for CWSs.

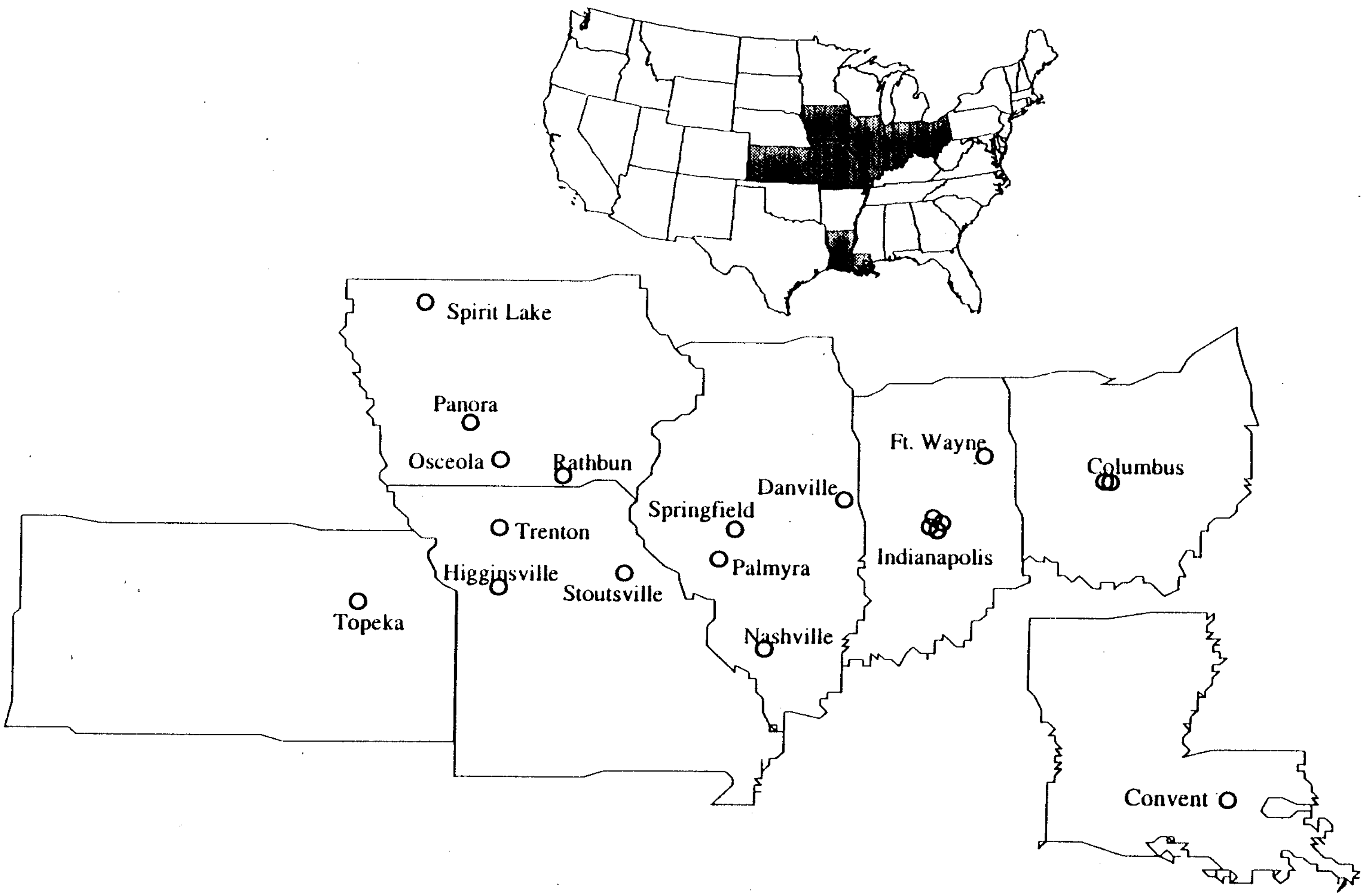


Figure 3-1. Locations of 20 Community Water System in 16 Cities in The Novartis Atrazine Monitoring Study

Figure 3-2. Novartis Voluntary Monitoring Study
DEA + DIA + DACT vs. Atrazine Concentration (Year)

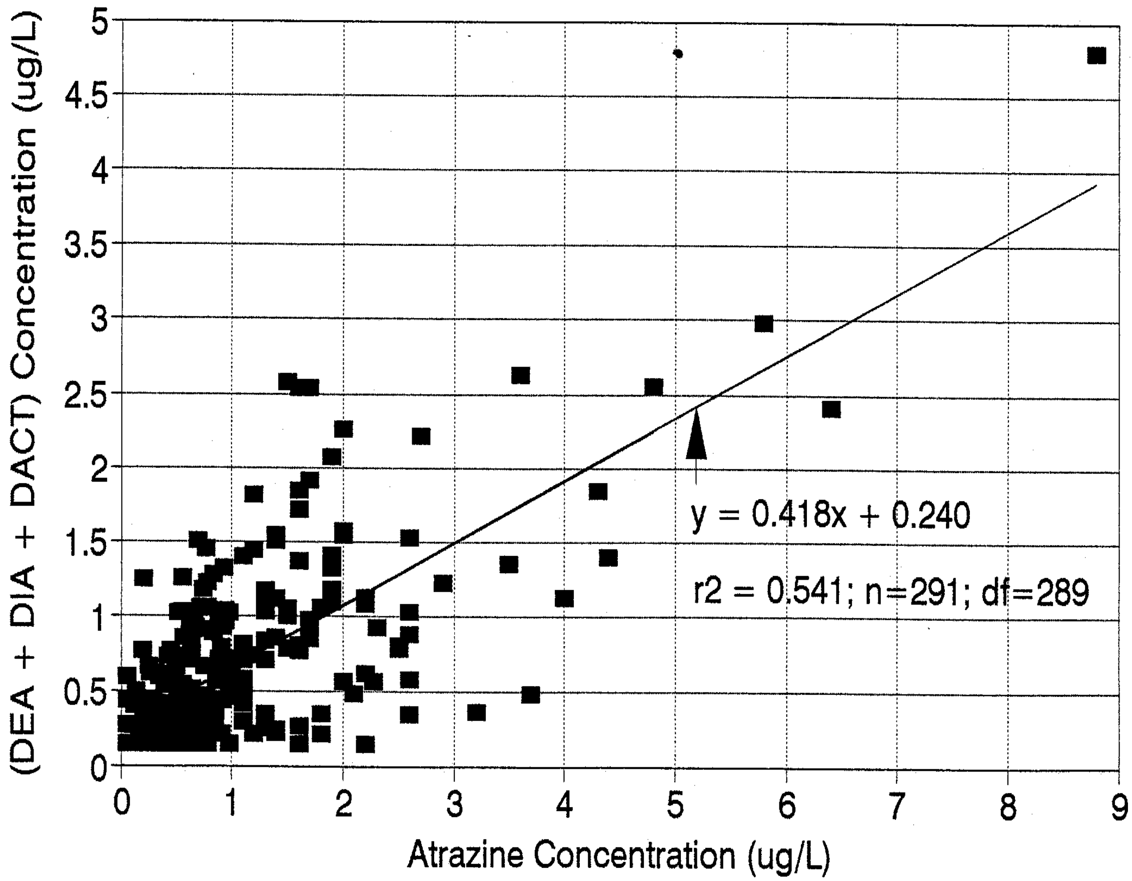


Figure 3-3. Novartis Voluntary Monitoring Study
DEA + DIA + DACT vs. Atrazine Concentration (1st Quarter)

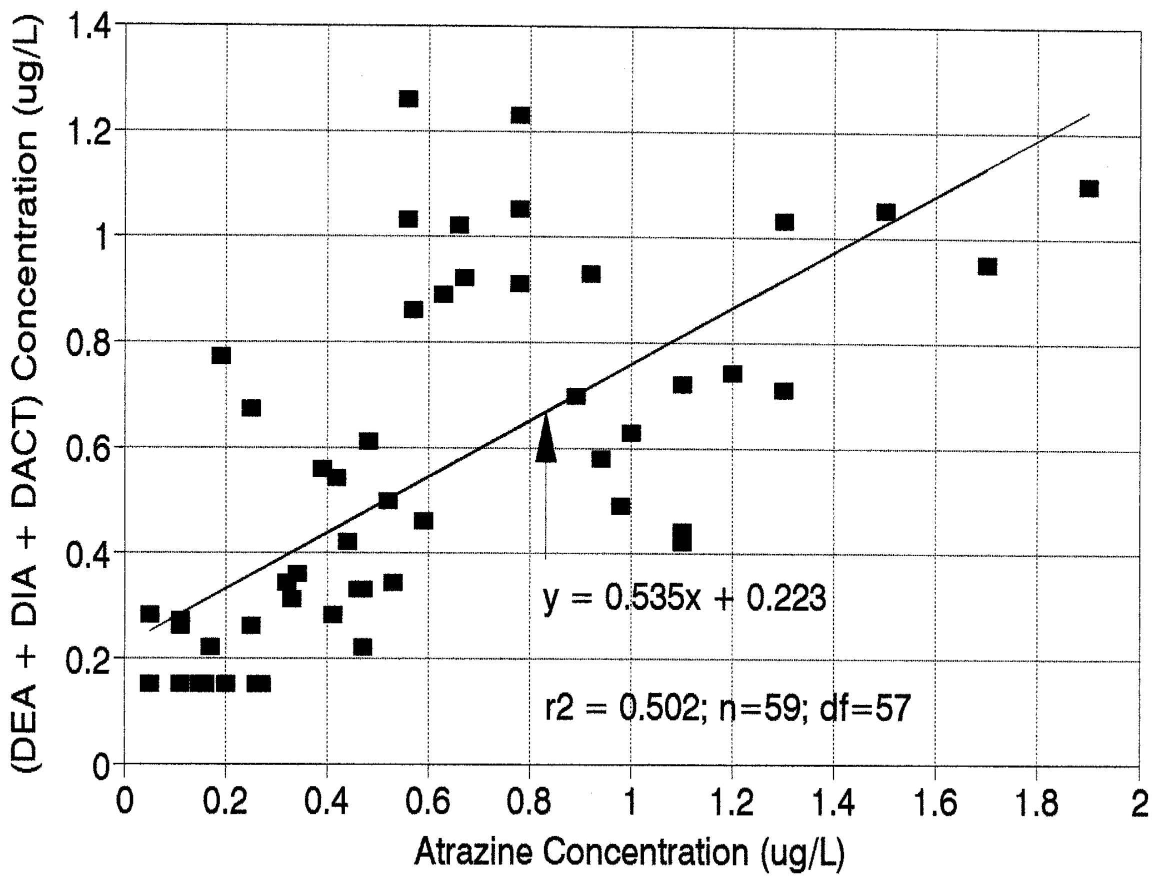


Figure 3-4. Novartis Voluntary Monitoring Study
DEA + DIA + DACT vs. Atrazine Concentration (2nd Quarter)

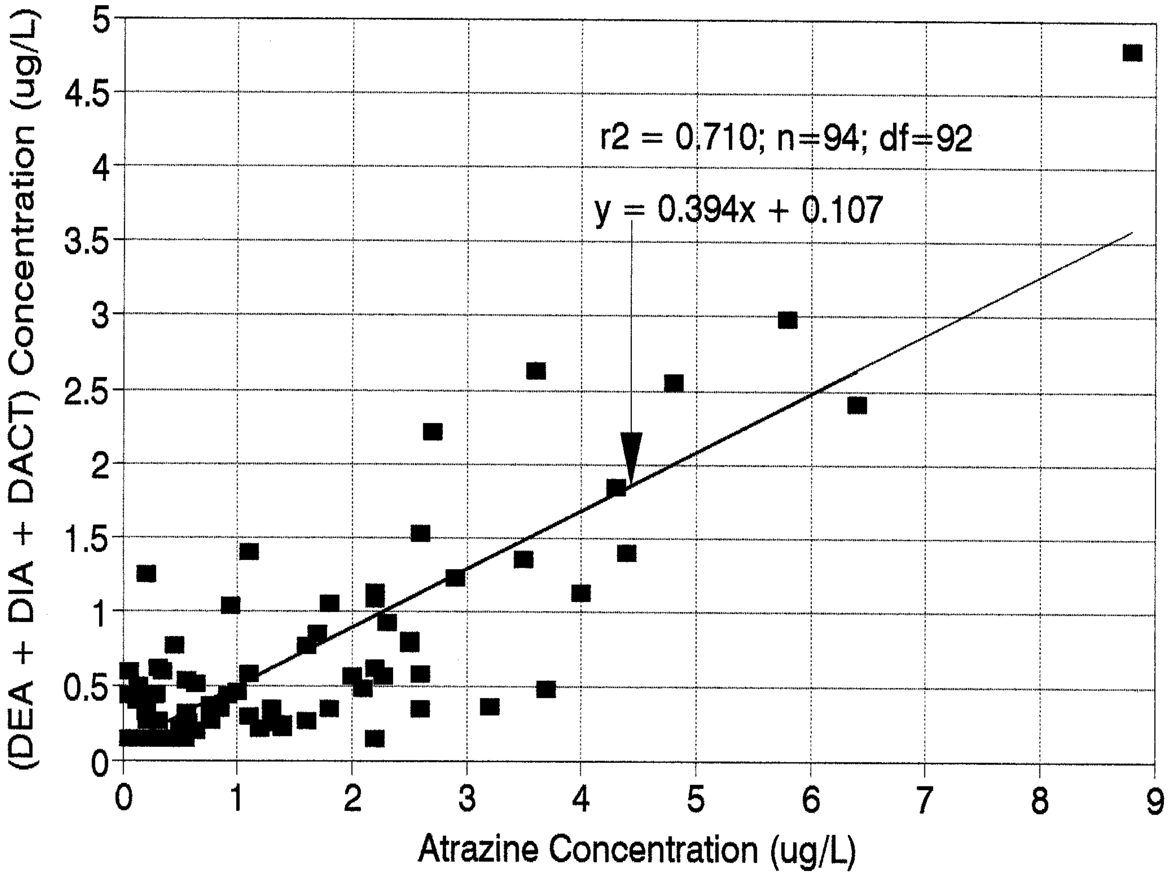


Figure 3-5. Novartis Voluntary Monitoring Study
DEA + DIA + DACT vs. Atrazine Concentration (3rd Quarter)

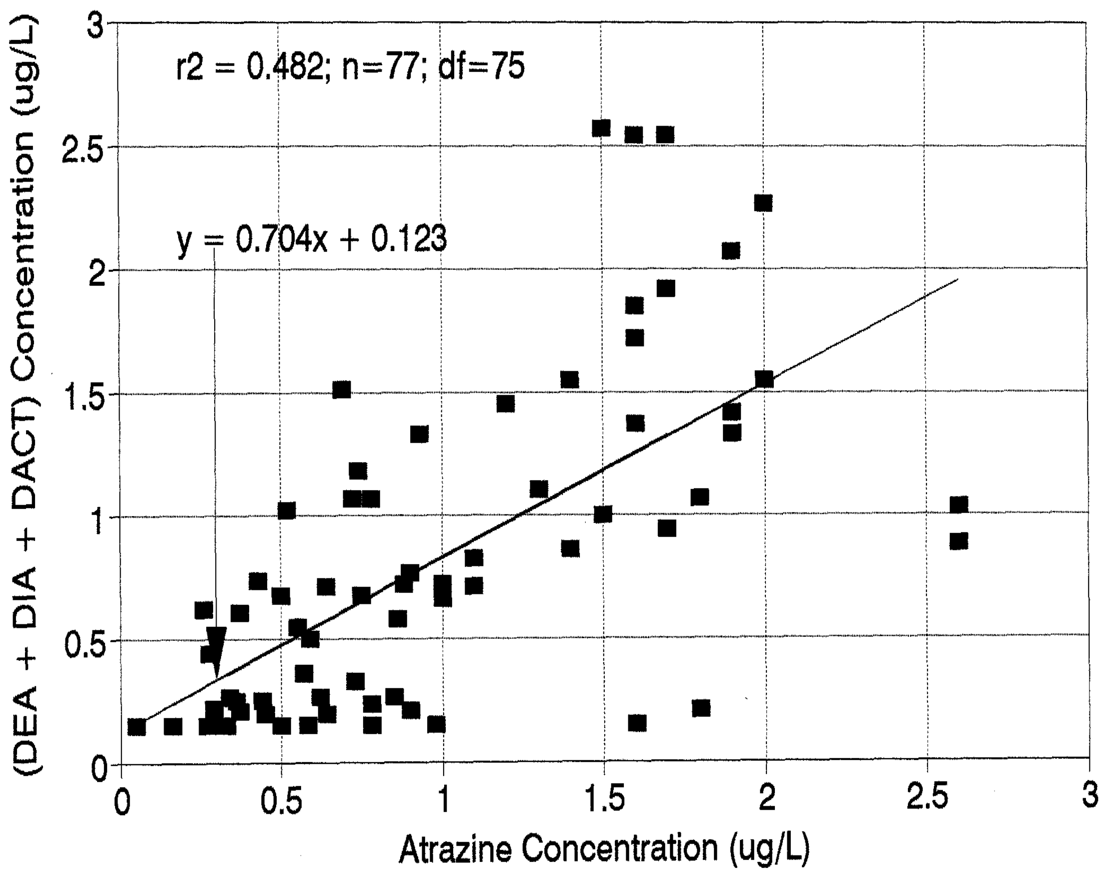


Figure 3-6. Novartis Voluntary Monitoring Study
DEA + DIA + DACT vs. Atrazine Concentration (4th Quarter)

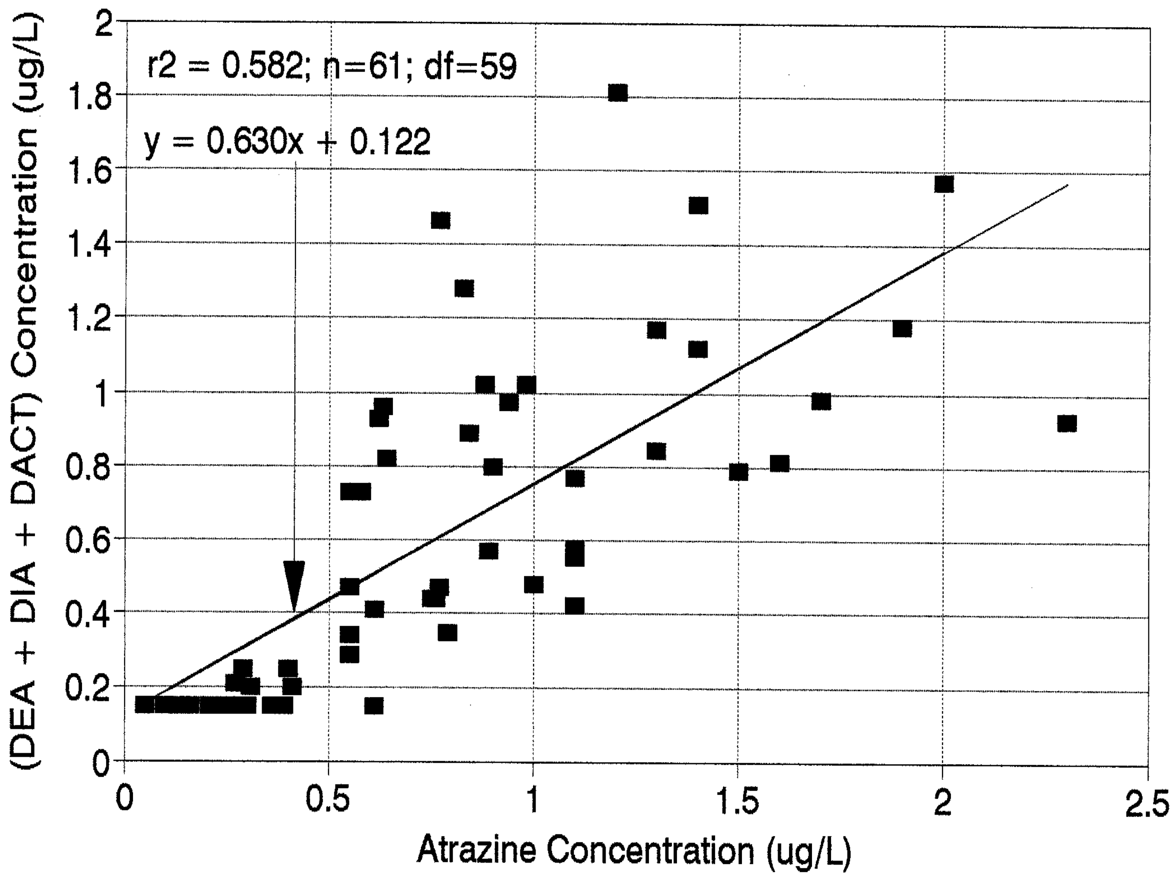


Figure 3-7. Novartis Voluntary Monitoring Study
Cumulative Exceedence Frequency Curves I (Year)

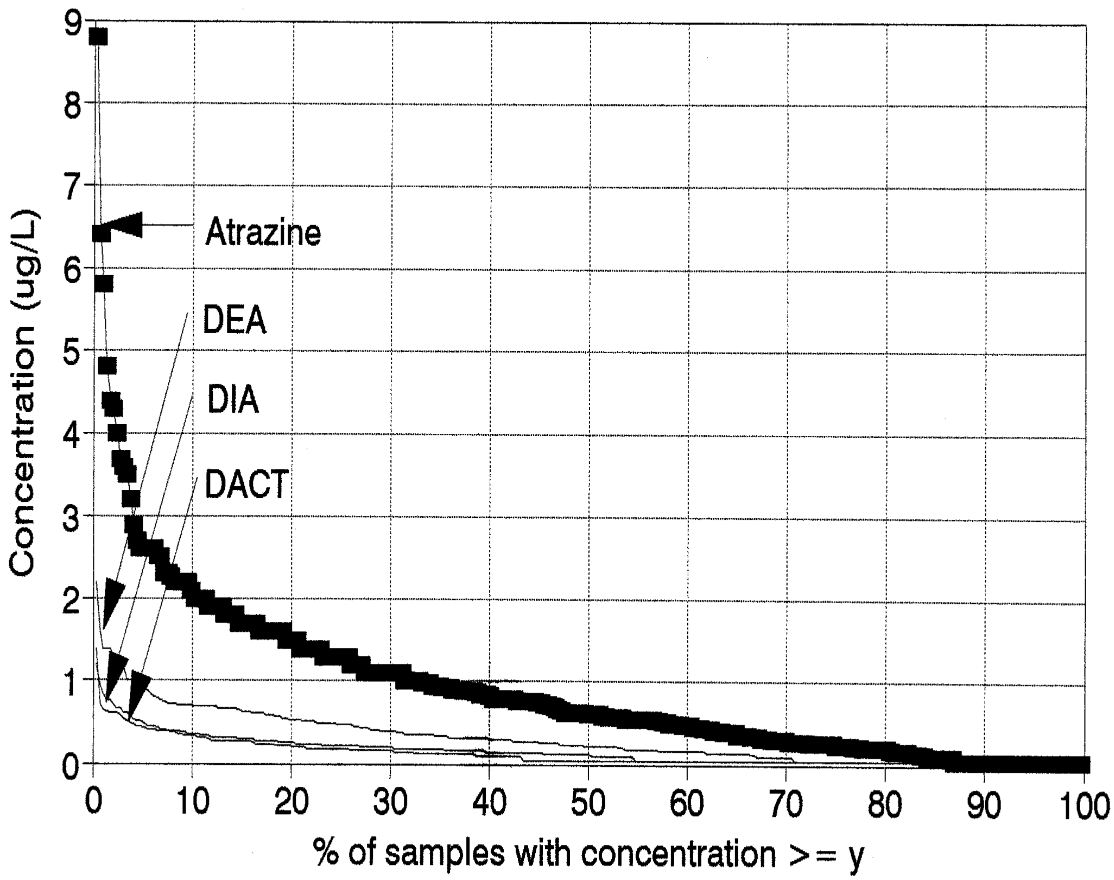


Figure 3-8. Novartis Voluntary Monitoring Study
Cumulative Exceedence Frequency Curves II (Year)

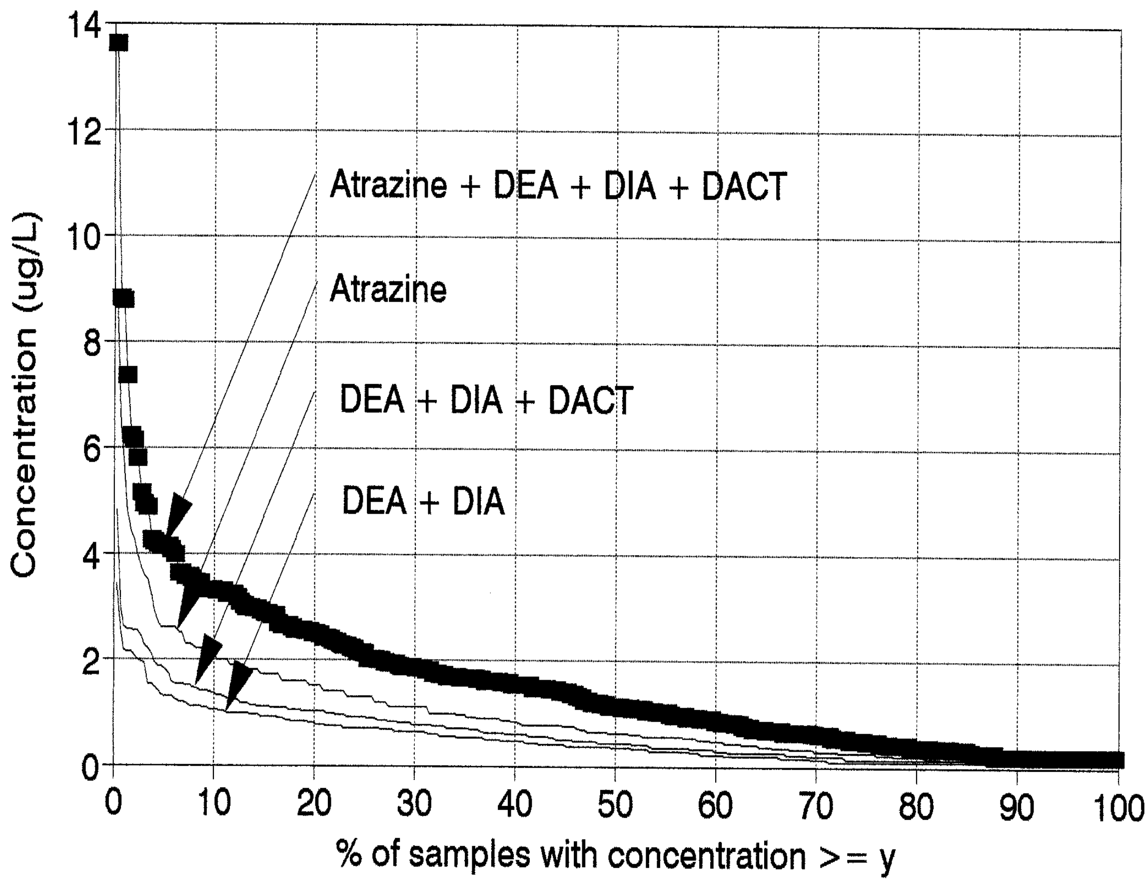


Figure 3-9. Novartis Voluntary Monitoring Study
1997 Atrazine Means
0 - 100% CWS Cumulative Exceedence Curve (n = 86)

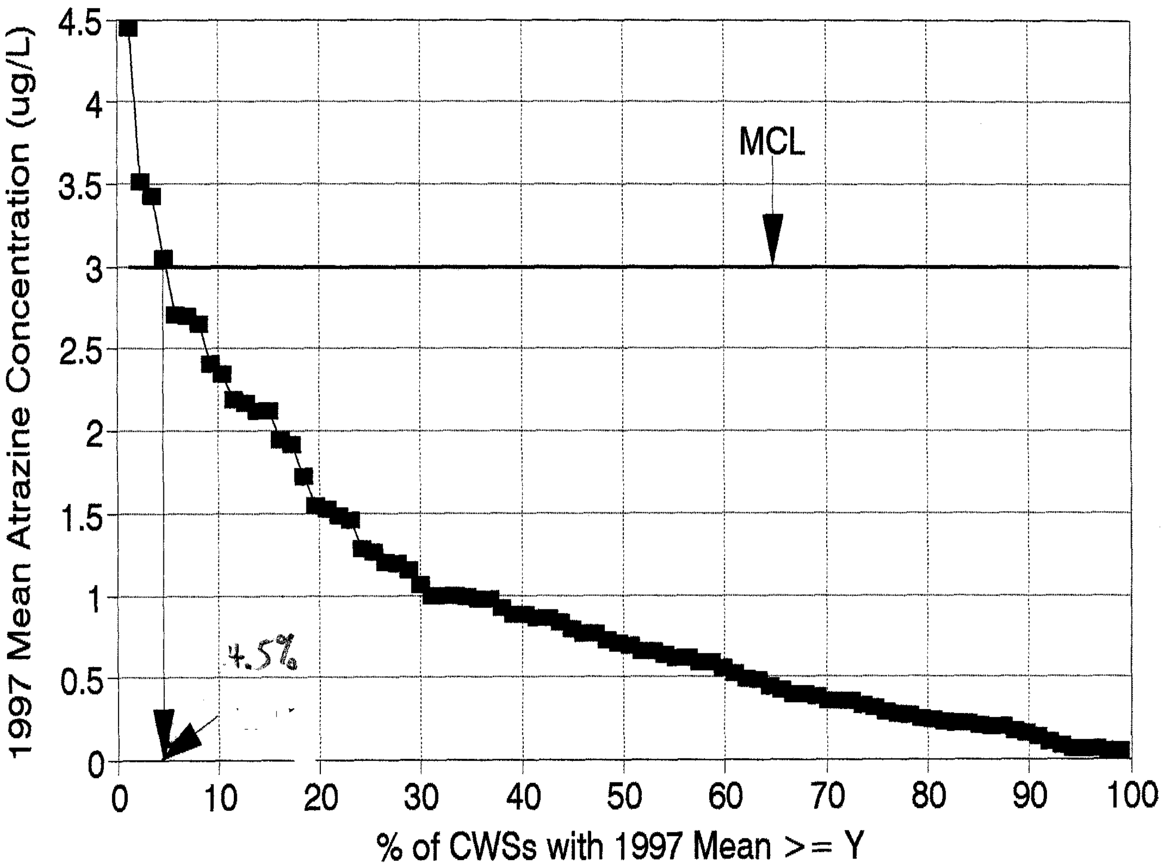
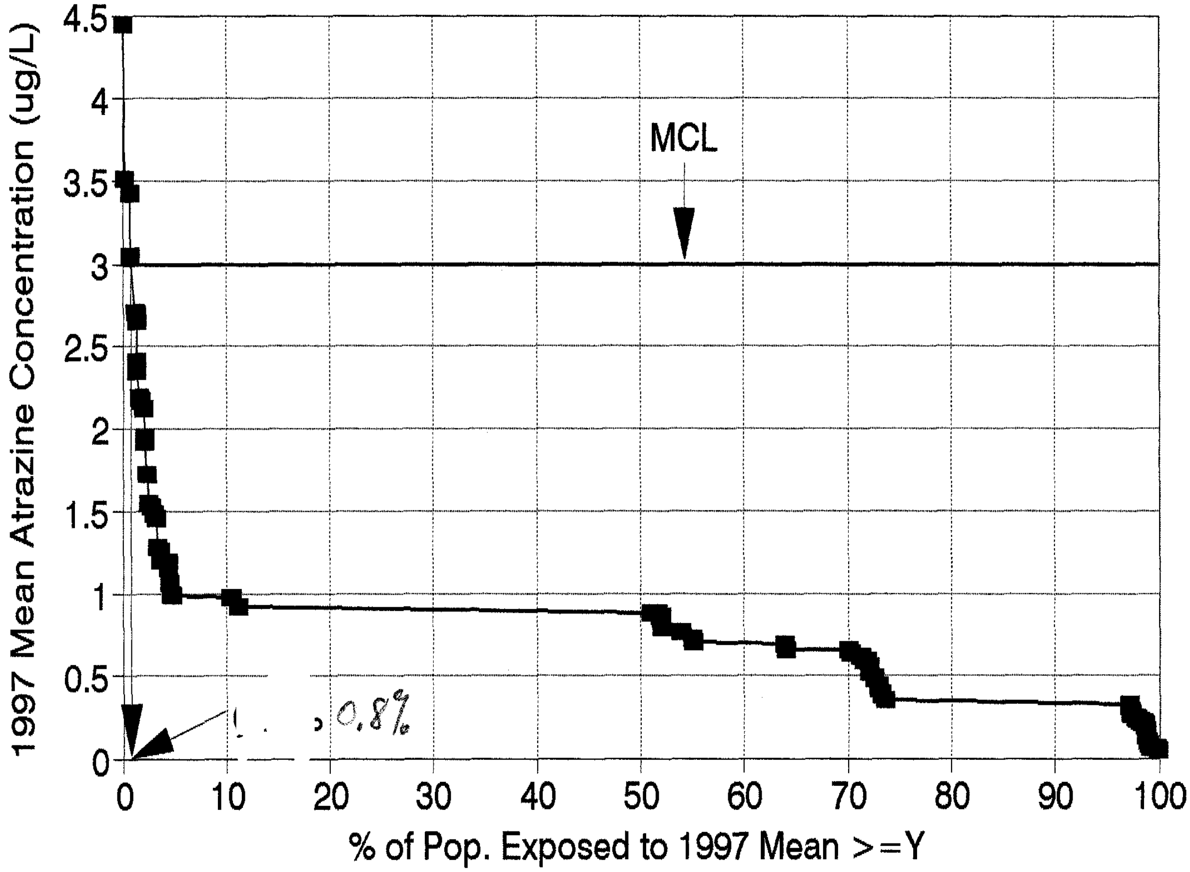


Figure 3-10. Novartis Voluntary Monitoring Study
1997 Atrazine Means
0 - 100% Population Cumulative Exceedence Curve (n = 2,107,091)



4. Novartis PLEX Database of Atrazine Concentrations in CWSs in 21 States

4.1) Description of Novartis PLEX Database of atrazine concentrations in CWSs in 21 states

Novartis has obtained for 21 "major use states" (Figure 4-1 which is Figure 1.1-1 of MRID 450587-04), a substantial amount of data on atrazine in the drinking water of Community Water Supplies (CWSs) (Table 4-1 which is Table 4.2-1 of MRID 450587-04). The data are for samples collected quarterly between January 1993 and December 1998 to comply with the monitoring requirements of the Safe Drinking Water Act (SDWA). Novartis developed the PLEX database to house the concentration data as well as associated data on populations served. The 21 states reportedly account for approximately 92% of atrazine use in the U.S.

Of the 21,241 CWSs in 21 states with atrazine data in the PLEX database through 1998, 2386 CWSs (11.2%) had one or more atrazine detections above limits of quantification (LOQs) (Table 4-2 which is Table 4.2-3 of MRID 450587-04). Of a total of 88,766 samples in the database, 8685 (9.8%) had detections above the LOQs (Table 4-2). The LOQs varied from 0.01 to 0.5 ug/L, but were typically at 0.1 ug/L (Table 4-3 which is Table 3.2-6 of MRID 450587-04).

The data submitted by CWSs under the SDWA and placed into the PLEX database do not include data on major degradates of atrazine such as the DEA, DIA, and DACT chloro-triazine degradates, or various hydroxy-triazine degradates. It is possible that such degradates could exert cumulative effects along with atrazine and together pose a substantially greater risk than atrazine by itself.

Despite the large volume of data in the PLEX database, there are little or no atrazine data available for numerous CWSs due primarily to waivers granted by the states (see percentages of CWSs with data in the PLEX database in Tables 4-1 and 4-2). Furthermore, the amount of data available for individual CWSs having data in the PLEX database vary widely from those only having data for one or two quarters of one year to those having four quarters of data for every year from 1993 through 1998. Therefore, the data in the PLEX database do not entirely represent a randomly sampled subset for the population across the 21 states. However, assuming that waiver grants are justified by existing monitoring data or use patterns that showed low atrazine contamination potential, the data in the PLEX database should be somewhat positively (conservatively) biased with respect to the CWSs sampled. Nevertheless, the degree of conservative bias for the PLEX database is much less than that for the Novartis Voluntary Monitoring Study discussed in Section 6.

Despite conservative bias with respect to the CWSs sampled, the PLEX database also has negative bias with respect to the sampling frequency of only one sample/quarter/CWS. The infrequent sampling means that the reported annual maximum atrazine concentration in the PLEX database for any given CWS in any given year is likely to be substantially less than the actual annual maximum atrazine concentration.

4.2) 1993-1998 atrazine annual means (from data in the Novartis PLEX database) and comparison to the Office of Drinking Water MCL for atrazine

EFED generated statistical summaries of 1993-1998 annual mean atrazine concentrations (from data in the PLEX database) are provided in Table 4-4. The Novartis generated cumulative exceedence tables (1st page of each) and curves upon which statistical summary Table 4-4 is based are provided in Sub-Appendix A-1 of Appendix A. To better clarify data close to the y axis, there are 3 different scale versions (0-100%, 0-5%, 0-1%) of each type of cumulative exceedence curve provided in Sub-Appendix A-1.

The percentiles and corresponding exceedence percentiles in statistical summary table 4-4 (as well as the cumulative exceedence graphs and tables upon which they are based) are given with respect to the % of the assessed population, not the % of the assessed CWSs. The reason for this is that with a large database of CWSs (where significant skewing by a small number of systems will not occur), an analysis with respect to the population served is more relevant to a risk assessment than one based with respect to the number of CWSs.

The highest annual mean atrazine concentrations for 1998, 1997, 1996, 1995, 1994, and 1993 were 6.60, 12.0, 10.4, 5.56, 11.8, and 4.30 ug/L, respectively. The 99.9th percentile annual mean atrazine concentrations for those years were 2.08, 3.47, 3.49, 3.36, 4.34, and 3.34 ug/L, respectively. The 99.5th percentile annual mean atrazine concentrations for those years were 1.71, 2.52, 2.58, 3.19, 3.22, and 2.15 ug/L, respectively. The 99th percentile annual mean atrazine concentrations for those years were 1.46, 2.46, 2.49, 2.20, 1.82, and 1.31 ug/L, respectively. The 95th percentile annual mean atrazine concentrations for those years were 0.99, 1.10, 1.50, 0.86, 0.70, and 0.63 ug/L, respectively.

The population and % of the assessed population served by 1998, 1997, 1996, 1995, 1994, and 1993 annual mean atrazine concentrations $\geq$ 3 ug/L were 16,000 people (0.02%), 129,000 people (0.18%), 156,000 people (0.19%), 506,000 people (0.79%), 331,000 people (0.58%), and (76,500 people (0.17%), respectively. The assessed populations for 1998, 1997, 1996, 1995, 1994, and 1993 were approximately 79.9, 71.6, 82.3, 64.0, 57.1, and 45.0 million, respectively.

The # of CWSs and % of the assessed CWSs with 1998, 1997, 1996, 1995, 1994, and 1993 annual mean atrazine concentrations $\geq$ 3 ug/L were 4 CWSs (0.05%), 26 CWSs (0.31%), 73 CWSs (0.92%), 11 CWSs (0.14%), 95 CWSs 1.49%), and 19 CWSs (0.49%), respectively.
The # of assessed CWSs in those years were 8548, 8300, 7944, 7909, 6395, and 3913 CWSs, respectively.

The identities of, and populations served by CWSs with annual means $\geq$ 3 ug/L can be obtained from the cumulative exceedence tables in Sub-Appendix A-1 or from the tables in Sub-Appendix A-2 (see Section 4.3)

4.3) CWSs in the Novartis PLEX database with one or more annual mean atrazine concentrations >= to the MCL of 3 ug/L

Of the 21,241 CWSs with atrazine data in the PLEX database, 182 CWSs had one or more annual mean atrazine concentrations $\geq$ the MCL of 3 ug/L during the 1993-1998 period (Tables 4-1 and 4-2). Of those 182 CWSs, 81 are suppliers and 101 are purchasers. Of the 81 suppliers, 74 , 5, and 2 have surface water, blend, and ground water sources, respectively. Of the 81 suppliers, 33 are in

Illinois, 16 are in Missouri, 12 are in Kansas, 12 are in Ohio, 4 are in Kentucky, 2 are in Indiana, and one each are in North Carolina and Texas (Table 4-2).

The 81 supplier CWSs with at least one annual mean atrazine concentration > MCL of 3 ug/L accounted for 96 annual means > MCL. Of the 81 supplier CWSs, 68 had only one annual mean > MCL, 11 had two annual means > MCL, and 2 had three annual means > MCL. The 96 annual means > than the MCL of 3 ug/L were distributed as follows: 3 ug/L $\leq$ ann. mean < 4 ug/L (50 means), 4 ug/L $\leq$ ann. mean < 6 ug/L (30 means), 6 ug/L $\leq$ ann. mean < 9 ug/L (11 means), and 9 $\leq$ ann. mean $\leq$ 12 ug/L (5 means).

Sub-Appendix A-2 lists 182 individual CWSs with one or more annual mean atrazine concentrations $\geq$ 3 ug/L, and the populations they serve.

4.4) 1993-1998 annual maximum atrazine concentrations (from data in the Novartis PLEX database) and comparison to Office of Drinking Water short term HALs for atrazine

EFED generated statistical summaries of 1993-1998 annual maximum atrazine concentrations (from data in the PLEX database) are provided in Table 4-5. The Novartis generated cumulative exceedence tables (1st page of each) and curves upon which statistical summary Table 4-5 is based are provided in Sub-Appendix A-3 of Appendix A. To better clarify data close to the y axis, there are 3 different scale versions (0-100%, 0-5%, 0-1%) of each type of cumulative exceedence curve provided in Sub-Appendix A-3.

As with Table 4-4, the percentiles and corresponding exceedence percentiles in statistical summary table 4-5 (as well as the cumulative exceedence graphs and tables upon which they are based) are with respect to the % of the assessed population, not the % of the assessed CWSs

The highest annual maximum atrazine concentrations for 1998, 1997, 1996, 1995, 1994, and 1993 were 14.2, 29.6, 42.0, 10.3, 30.0, and 14.0 ug/L, respectively. The 99.9th percentile annual maximum atrazine concentrations for those years were 10.1, 18.4, 11.0, 7.84, 15.0, and 14.0 ug/L, respectively. The 99.5th percentile annual maximum atrazine concentrations for those years were 7.00, 5.87, 5.99, 6.49, 8.10, and 6.60 ug/L, respectively. The 99th percentile annual maximum atrazine concentrations for those years were 4.80, 4.16, 4.47, 5.37, 4.30, and 6.50 ug/L, respectively. The 95th percentile annual maximum atrazine concentrations for those years were 1.47, 2.50, 1.80, 2.40, 1.30, and 1.20 ug/L, respectively.

The highest atrazine concentration (42 ug/L) reported in the PLEX database from 1993 through 1998 is well below the Office of Drinking Water short term HALs for atrazine of 100 ug/L.

The assessed populations for 1998, 1997, 1996, 1995, 1994, and 1993 were approximately 79.9, 71.6, 82.3, 64.0, 57.1, and 45.0 million, respectively. The # of assessed CWSs in those years were 8548, 8300, 7944, 7909, 6395, and 3913 CWSs, respectively.

4.5) Regression estimated, 1993-1998 annual mean total chloro-triazine concentrations (from data in the surface water portion of the Novartis PLEX database) and comparison to HED sub-chronic/chronic DWLOCs for total chloro-triazines

EFED generated statistical summaries of regression estimated, 1993-1998 annual mean total chloro-triazine (atrazine + DEA + DIA + DACT) concentrations (from data in the surface water portion of the PLEX database) are provided in Table 4-6. The EFED generated cumulative exceedence tables (1st page of each) and curves upon which statistical summary Table 4-6 is based are provided in Sub-Appendix A-4 of Appendix A.

As with Tables 4-4 and 4-5, the percentiles and corresponding exceedence percentiles in statistical summary table 4-6 (as well as the cumulative exceedence graphs and tables upon which they are based) are given with respect to the % of the assessed population, not the % of the assessed CWSs.

The regression estimated, highest annual mean total chloro-triazine concentrations in surface water source CWSs for 1998, 1997, 1996, 1995, 1994, and 1993 were 9.60, 7.43, 15.0, 8.13, 17.0, and 6.34 ug/L, respectively. The 99.9th percentile annual mean total chloro-triazine concentrations for those years were 3.44, 5.67, 6.42, 5.46, 8.74, and 5.05 ug/L, respectively. The 99.5th percentile annual mean total chloro-triazine concentrations for those years were 2.72, 4.33, 4.46, 5.24, 5.72, and 3.30 ug/L, respectively. The 99th percentile annual mean total chloro-triazine concentrations for those years were 2.63, 3.74, 3.81, 4.97, 4.88, and 3.27 ug/L, respectively. The 95th percentile annual mean total chloro-triazine concentrations for those years were 1.66, 2.12, 2.39, 1.65, 1.70, and 1.54 ug/L, respectively.

The regression estimated, highest annual mean total chloro-triazine concentration (17 ug/L) for surface water source CWSs in the PLEX database from 1993 through 1998 is slightly below the sub-chronic/chronic HED DWLOC of 18 ug/L for children and infants and well below the sub-chronic/chronic HED DWLOC of 63 ug/L for adults.

The assessed populations in the surface water portion of the Novartis PLEX database for 1998, 1997, 1996, 1995, 1994, and 1993 were approximately 44.0, 38.2, 41.5, 31.4, 24.0, and 23.9 million, respectively. The # of assessed surface water source CWSs in those years were 2494, 2132, 2547, 1699, 1700, and 1212, respectively.

4.6) Regression estimated, 1993-1998 annual maximum total chloro-triazine concentrations (from data in the surface water portion of the Novartis PLEX database) and comparison to HED acute and chronic DWLOCs for total chloro-triazines

EFED generated statistical summaries of regression estimated, 1993-1998 annual maximum total chloro-triazine (atrazine + DEA + DIA + DACT) concentrations (from data in the surface water portion of the PLEX database) are provided in Table 4-7. The EFED generated cumulative exceedence tables and tables upon which statistical summary Table 4-7 is based are provided in Sub-Appendix A-5 of Appendix A.

As with Tables 4-4, 4-5, and 4-6, the percentiles and corresponding exceedence percentiles in statistical summary table 4-7 (as well as the cumulative exceedence graphs and tables upon which they are based) are listed with respect to the % of the assessed population, not the % of the assessed CWSs.

The regression estimated, highest annual maximum total chloro-triazine concentrations in surface water source CWSs for 1998, 1997, 1996, 1995, 1994, and 1993 were 20.4, 42.2, 59.8, 14.8, 42.8, and 20.1 ug/L, respectively. The 99.9th percentile annual maximum total chloro-triazine concentrations for those years were 14.6, 32.2, 18.3, 12.3, 22.8, and (not computed for 1993) ug/L, respectively. The 99.5th percentile annual maximum total chloro-triazine concentrations for those years were 13.2, 12.8, 9.81, 11.1, 20.9, and (not computed for 1993) ug/L, respectively. The 99th percentile annual maximum total chloro-triazine concentrations for those years were 7.57, 8.27, 6.70, 9.36, 12.8, and 9.59 ug/L, respectively. The 95th percentile annual maximum total chloro-triazine concentrations for those years were 2.79, 4.86, 3.64, 7.00, 5.77, and 3.37 ug/L, respectively.

The regression estimated, highest total chloro-triazine concentration (59.8 ug/L) for surface water source CWSs in the PLEX database from 1993 through 1998 is well below the single HED acute DWLOC of 298 ug/L (for pregnant women).

In the frequent case where a CWS was not sampled in either the VMS or ARP surface water monitoring study, the EFED decided to use PLEX based, regression estimated, annual maximum total chloro-triazine concentrations as surrogates for regression estimated, annual maximum quarterly mean total chloro-triazine concentrations for comparison to HED sub-chronic/chronic DWLOCs for total chloro-triazines. The reason is that in the PLEX database of atrazine data (collected to comply with the monitoring requirements of the SDWA), the annual maximum reported atrazine concentration for a CWS also represents its annual maximum reported 3-month quarterly mean because only one sample is generally collected per quarter (3 months).

In some cases, the PLEX based, regression estimated, annual maximum total chloro-triazine concentration will overestimate a VMS and/or ARP based, regression estimated, annual maximum quarterly mean total chloro-triazine concentration. In other cases, it will underestimate it. That can be seen by a comparison of PLEX based, regression estimated, annual maximum total chloro-triazine concentrations to VMS and/or ARP based, regression estimated, annual maximum quarterly mean total chloro-triazine concentrations for those CWSs with data in both the PLEX and VMS and/or ARP databases. For example, in 1998, 1997, 1996, 1995, 1994, and 1993, PLEX based, regression estimated, annual maximum total chloro-triazine concentrations were less than VMS based, regression estimated, annual maximum quarterly mean total chloro-triazine concentrations in 51% (38/74), 57% (41/72), 57% (40/70), 39% (26/66), and 38% (19/50), respectively, of the CWSs with data in both the PLEX and VMS database. Likewise, they were greater in 49%, 43%, 43%, 61%, and 62% of the CWSs, respectively.

The use of PLEX based, regression estimated, annual total chloro-triazine concentrations as surrogates for regression estimated, annual maximum quaterly mean total chloro-triazine concentrations (for comparison to HED sub-chronic/chronic DWLOCs) is not necessary for the those few CWSs for which data were collected in either the VMS or ARP surface monitoring study in the same years. The reason is that regression estimated, annual maximum quarterly mean total chloro-triazine concentrations can be derived for those CWSs based upon the greater time series data in the VMS or ARP.

In the frequent case where a CWS was not sampled in the VMS and/or ARP surface water monitoring study, the EFED compared its PLEX based, regression estimated, annual maximum total chloro-triazine concentrations to HED sub-chronic/chronic DWLOCs for total chloro-triazines. In cases where a CWS was sampled in the VMS and/or ARP studies, its VMS and/or ARP based, regression estimated, annual maximum quarterly mean total chloro-triazine concentrations were compared to HED sub-chronic/chronic DWLOCs for total chloro-triazines.

The EFED summed the # of CWSs with no VMS and/or ARP data but with PLEX based, regression estimated, annual maximum total chloro-triazine concentrations $\geq$ the HED sub-chronic/chronic DWLOC of 18 ug/L for children and infants **and** the # of CWSs with VMS and/or ARP based, regression estimated, annual maximum quarterly mean total chloro-triazine concentrations $\geq$ 18 ug/L. In 1998, 1997, 1996, 1995, 1994, and 1993, the summed CWSs were 3 CWSs (0.12%), 7 CWSs (0.33%), 9 CWSs (0.35%), 0 CWSs (0.0%), 23 CWSs (1.35%), and 9 CWSs (0.74%), respectively. The # of assessed surface water source CWSs in those years were 2494, 2132, 2547, 1699, 1700, and 1212 CWSs, respectively.

The corresponding population and the % of the assessed population in 1998, 1997, 1996, 1995, 1994, and 1993 were 2502 people (0.006%), 85,503 people (0.22%), 26,464 people (0.06%), 0 people (0.0%), 201,375 people (0.84%), and 199,106 people (0.83%), respectively. The assessed populations in the surface water portion of the Novartis PLEX database for 1998, 1997, 1996, 1995, 1994, and 1993 were approximately 44.0, 38.2, 41.5, 31.4, 24.0, and 23.9 million, respectively.

The identities of, and populations served by CWSs with annual maximum total chloro-triazine concentrations $\geq$ the HED sub-chronic/chronic DWLOC of 18 ug/L for children and infants can be obtained from the cumulative exceedence tables in Sub-Appendix A-5.

The regression estimated, highest annual maximum total chloro-triazine concentration (59.8 ug/L) for surface water source CWSs in the PLEX database from 1993 through 1998 was slightly below the HED sub-chronic/chronic DWLOC of 63 ug/L for adults.

Figure 4-1. Atrazine and Simazine Major Use States

TABLE 4-1
PLEX DATA FOR ATRAZINE
JANUARY 1993 - DECEMBER 1998

	Totals	Groundwater	Surface Water	Other
Data				
Number of Samples	88,766	68,616	15.362	4,788
Number of Detections	8,685	2,435	5,717	533
Percent of Detections	9.8	3.5	37.2	11.1
Number of Detections > 3 ppb	782	26	706	50
Percent of Detections > 3 ppb	9.0	1.1	t 2.3	9.4
Percent of Samples > 3 ppb	0.9	0.04	4.6	1.0
Concentrations (pub)				
Minimum Detected Concentration	0.003	0.02	0.003	0.01
Maximum Detected Concentration	42.00	7.90	42.00	23.00
Population-Weighted Exposure Concentrations'	0.29	0.26	0.30	0.33
CWS				
Number of CWS		26,317	4,886	1,054
Number of CWS with Data	21,241	16,865	3,670,	706
Percent CWS with Data	65.8	64.1	75.1	67.0
Number of CWS with *No* Detections	18,855	16?209	2,154	492
Number of CWS with Detections	2,386	656	1,516	214
Number of CWS with Detections > 3 ppb	503	18	433	52
Number of CWS with Annual Means > 3 ppb	182	3	173	6
Number of CWS with Period Means > 3 ppb	7	0	6	1
Percent of CWS with *No* Detections	88.8	96.1	583	69.7
Percent of CWS with Detections	11.2	3.9	41.3	30.3
Percent of CWS with Detections > 3 ppb	2.4	0.1	11.8	7.4
Percent of CWS with Annual Means > 3'ppb	0.9	0.02	4.7	0.8
Percent of CWS with Period Means > 3 ppb	0.03	0	0.2	0.1
Populations				
Major Use Population	175,488,991			
Population on CWS	166,885,758	73,856,519	75,359,918	17,669,321
Population Served by CWS with Data	135,744,897	55,440,483	64,943,203	15,361,211
Percent Population Assessed	77.4	31.6	37.0	8.8
Percent CWS Population Assessed	81.3	75.1	86.2	86.9
Population with No Detections [2]	101,049,824	52,978,518	39,714,176	8,357,130
Population with Detections	34,695,073	2,46t.965	25,229,027	7,004,081
Population with Detections > 3 ppb	7,479,113	194,459	5,118,565	2,166,089
Populations with Annual Means > 3 ppb	1,107,141	2,110	1,084,197	20,834
Populations with Period Means > 3 ppb	40,915	0	29,652	11,263
Percent of population with No Detections	74.4	95.6	61.2	54.4
Percent of population with Detections	25.6	4.4	38.8	45.6
Percent of population with Detections > 3 ppb	5.5	0.4	7.9	14.1
Percent of population with Annual Means > 3 ppb	0.8	0.004	1.7	0.1
Percent of population with Period Means > 3 ppb	0.03	0	0.05	0.1

[1] Simple substitution method
[2] Percent CWS and populations with or without detects are based on the number of assessed CWS and populations, respectively.

TABLE 4-2

ATRAZINE IN MAJOR USE STATES: CWS WITH DATA, DETECTIONS, ANNUAL AND PERIOD ATRAZINE MEAN CONCENTRATIONS >3.0 PPB

State	No. CWS in State	No. CWS with Data	No. CWS with Detections	No. CWS with Annual Means >3 ppb Suppliers	No. CWS with Annual Means >3 ppb Purchasers	No. CWS with Period Means >3 ppb Suppliers	No. CWS with Period Means >3 ppb Purchasers
California	3,147	869	3	0	0	0	0
Delaware	230	152	5	0	0	0	0
Florida	2,062	1,677	1	0	0	0	0
Hawaii	120	119	15	0	0	0	0
Illinois[1]	1,796	1,742	474	33	49	2	0
Indiana	884	847	85	2	0	0	0
Iowa	1,147	1,118	198	0	0	0	0
Kansas	911	874	484	11	17	0	0
Kentucky	503	456	127	4	0	2	0
Louisiana[2]	1,391	895	41	0	0	0	0
Maryland	512	385	28	0	0	0	0
Michigan	1,623	1,431	8	0	0	0	0
Minnesota	957	947	21	0	0	0	0
Missouri	1,438	1,331	161	16	21	1	0
Nebraska	620	602	98	0	0	0	0
New York	3,307	899	11	0	0	0	0
North Carolina	2,310	2,248	37	1	2	0	0
Ohio	1,436	1,419	120	13	5	2	0
Pennsylvania	2,218	812	29	0	0	0	0
Texas[2]	4,487	1,696	395	1		0	0
Wisconsia.	1,158	722	45	0	0	0	0
Total	32,257	21,241	2,386	81	101	7	0
% of CWS with data		66%	11.23%	0.38%	0.48%[3]	0.03%[3]	0.00%

[1] Data reported as "non detect" from Illinois were not QA/QC'd by the state.

[2] Data from Texas and Louisiana are from January 1996 to December 1998.

[3] Includes purchasers and suppliers added together 0.88% for annual mean

TABLE 4-3

ATRAZINE LIMITS OF QUANTIFICATION REPORTED BY THE 21 MAJOR USE STATES WITH DATA, 1993 - 1998

State	Limit of Quantification (ppb)	Range (ppb)
California	1.0 a	0.1 - 1.9
Delaware	0.1 a	0.07 - 0.1
Florida	0.1	--
Hawaii	0.25	0.05 - 0.5
Illinois	0.3	0.05 - 0.54
Indiana	0.3 a	0.05 - 1.1
Iowa	0.1 a	0.1 - 1.3
Kansas	0.1 a	0.1 - 1.2
Kentucky	0. t a	0.047 - 8.22
Louisiana	0.3 a	0.1 - 2,5
Maryland	0.2 a	0.0005 - 5.0
Michigan	0.1 a	0.1 - 0.2
Minnesota	0.3 a	0.3 - 0.5
Missouri	0.5 a	0.01 - 0.5
Nebraska	0.08 a	0.079 - 0.1
New York	0.5 a	0.05 - 3.0
North Carolina	0.1	--
Ohio	0.1 a	0.02 -1.3
Pennsylvania	0.1	
Texas	0.2 a	0.02 - 3.0
Wisconsin	0.1 a	0.01 - 2.0

a Data from the state had several Quantification limits.

The value listed is the most frequently reported number.

Table 4-4. EFED generated statistical summary of 1993-1998 annual mean atrazine concentrations from data in the Novartis PLEX database on ground, surface, and blend water source CWSs. The percentiles are based on the percentages of the assessed population exposed to an equal or lesser concentration.

Population Percentile	Exceedence Percentile	1998 Ann Means	1997 Ann Means	1996 Ann Means	1995 Ann Means	1994 Ann Means	1993 Ann Means
Highest	-	6.60	12.00	10.40	5.56	11.80	4.30
99.90%	0.10%	2.08	3.47	3.49	3.26	4.34	3.34
99.50%	0.50%	1.71	2.52	2.58	3.19	3.22	2.15
99%	1%	1.46	2.46	2.49	2.20	1.82	1.31
95%	5%	0.99	1.10	1.50	0.86	0.70	0.63
90%	10%	0.69	0.50	0.94	0.53	0.50	0.25
75%	25%	0.50	0.50	0.50	0.33	0.25	0.14
50%	50%	0.25	0.15	0.15	0.17	0.15	0.10
Total CWS assessed		8548	8300	7944	7909	6395	3913
Total Pop. Assessed		7.99E+07	7.17E+07	8.23E+07	6.40E+07	5.71E+07	4.50E+07
% CWSs >= 3 ug/L		0.05%	0.31%	0.92%	0.14%	1.49%	0.49%
# CWS >= 3 ug/L		4	26	73	11	95	19
% Pop. Exp. >= 3 ug/L		0.02%	0.18%	0.19%	0.79%	0.58%	0.17%
Pop. Exp. >= 3 ug/L		16,000	129,000	156,000	506,000	331,000	76,500

Atrazine MCL = 3 ug/L

Table 4-5. EFED generated statistical summary of 1993-1998 annual maximum atrazine concentrations from data in the Novartis PLEX database on ground, surface, and blend water source CWSs. The percentiles are based on the percentages of the assessed population exposed to an equal or lesser concentration.

Population Percentile	Exceedence Percentile	1998 Maximum	1997 Maximum	1996 Maximum	1995 Maximum	1994 Maximum	1993 Maximum
Highest	-	14.20	29.58	42.00	10.26	30.00	14.00
99.90%	0.10%	10.07	18.36	11.00	7.84	15.00	14.00
99.50%	0.50%	7.00	5.87	5.99	6.49	8.10	6.60
99%	1%	4.80	4.16	4.57	5.37	4.30	6.50
95%	5%	1.47	2.50	1.80	2.40	1.30	1.20
90%	10%	1.00	1.10	1.50	1.17	0.50	0.40
75%	25%	0.50	0.50	0.50	0.50	0.30	0.30
50%	50%	0.25	0.15	0.20	0.25	0.15	0.10
Total CWS assessed		8548	8300	7944	7909	6395	3913
Total Pop. Assessed		7.99E+07	7.17E+07	8.23E+07	6.40E+07	5.71E+07	4.50E+07
% CWSs >= 3 ug/L		0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
# CWS >= 3 ug/L		0	0	0	0	0	0
% Pop. Exp. >= 3 ug/L		0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Pop. Exp. >= 3 ug/L		0	0	0	0	0	0

Atrazine short term HAL = 100 ug/L

Table 4-6. EFED generated statistical summary of regression estimated, annual mean total chloro-triazine (atrazine + DEA + DIA + DACT) concentrations from data in the surface water portion of Novartis PLEX database. The percentiles are based on the percentages of the assessed population exposed to an equal or lesser concentration.

Population Percentile	Exceedence Percentile	Based on Annual Mean					
Year		1998	1997	1996	1995	1994	1993
Highest	-	9.5988	7.4293	14.9801	8.1303	16.9724	6.3374
99.90%	0.10%	3.4411	5.6663	6.4230	5.4580	8.7402	5.0528
99.50%	0.50%	2.7209	4.3340	4.4559	5.2389	5.7201	3.3013
99%	1%	2.6258	3.7378	3.8080	4.9650	4.8812	3.2744
95%	5%	1.6580	2.1166	2.3844	1.6485	1.6973	1.5375
90%	10%	1.4356	1.7285	1.5753	1.4590	1.2386	0.7450
75%	25%	0.9490	0.9185	0.9260	0.7219	0.9490	0.4350
50%	50%	0.4527	0.4527	0.4527	0.4784	0.5070	0.4350
Total CWS assessed		2494	2132	2547	1699	1700	1212
Total Pop. Assessed		4.40E+07	3.82E+07	4.15E+07	3.14E+07	2.40E+07	2.39E+07
% CWSs >= 18 ug/L		0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
# CWS >= 18 ug/L		0	0	0	0	0	0
% Pop. Exp. >= 18 ug/L		0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Pop. Exp. >= 18 ug/L		0	0	0	0	0	0

Total chloro-triazine sub-chronic/chronic DWLOC = 18 ug/L for children and infants

Total chloro-triazine sub-chronic/chronic DWLOC = 63 ug/L for adults

Table 4-6. EFED generated statistical summary of regression estimated, annual maximum total chloro-triazine (atrazine + DEA + DIA + DACT) concentrations from data in the surface water portion of Novartis PLEX database. The percentiles are based on the percentages of the assessed population exposed to an equal or lesser concentration.

Population Percentile	Exceedence Percentile	Based on Annual Peak							
Year		1998	1997	1996	1995	1994	1993		
Highest	-	20.3756	42.1844	59.7960	14.7887	42.7800	20.0920		
99.90%	0.10%	14.5507	32.1973	18.2712	12.2550	22.7982			
99.50%	0.50%	13.2259	12.8020	9.8099	11.1376	20.9308			
99%	1%	7.5708	8.2663	6.7033	9.3565	12.8003	9.5882		
95%	5%	2.7924	4.8570	3.6432	7.0049	5.7702	3.3689		
90%	10%	1.9416	3.6645	2.6506	2.5088	2.7924	1.1170		
75%	25%	1.5020	1.0908	1.3370	0.9490	0.9490	0.5945		
50%	50%	0.5945	0.4527	0.4527	0.5945	0.5236	0.5945		
Total CWS assessed		2494	2132	2547	1699	1700	1212		
Total Pop. Assessed		4.40E+07	3.82E+07	4.15E+07	3.14E+07	2.40E+07	2.39E+07		
% CWSs >= 298 ug/L		0.00%	0.00%	0.00%	0.00%	0.00%	0.00%		
# CWS >= 298 ug/L		0	0	0	0	0	0		
% Pop. Exp. >= 298 ug/L		0.00%	0.00%	0.00%	0.00%	0.00%	0.00%		
Pop. Exp. >= 298 ug/L		0	0	0	0	0	0		
% CWSs >= 18 ug/L		0.080%	0.422%	0.746%	0.00%	1.765%	0.248%		
# CWS >= 18 ug/L		2	9	19	0	30	3		
% Pop. Exp. >= 18 ug/L		0.003%	0.277%	0.098%	0.00%	0.876%	0.771%		
Pop. Exp. >= 18 ug/L		1,450	105,721	40,586	0	210,544	184,092		
% CWSs >= 63 ug/L		0.00%	0.00%	0.00%	0.00%	0.00%	0.00%		
# CWS >= 63 ug/L		0	0	0	0	0	0		
% Pop. Exp. >= 63 ug/L		0.00%	0.00%	0.00%	0.00%	0.00%	0.00%		
Pop. Exp. >= 63 ug/L		0	0	0	0	0	0		

Total chloro-triazine acute DWLOC is 298 ppb for the subgroup females 13 - 50

Total chloro-triazine sub-chronic/chronic DWLOC is 18 ug/L for children and infants

Total chloro-triazine sub-chronic/chronic DWLOC is 63 ug/L for adults

5. Novartis/States Rural Well Survey of Atrazine, Chloro-triazine Degradates and Hydroxy-Triazine Degradates in 1500 Rural Wells

5.1 Description of the Rural Well Survey

The Novartis/State groundwater monitoring study represents a rural private water well sampling program designed to augment available groundwater monitoring data on the occurrence of atrazine and its degradation products in groundwater in vulnerable regions of major use areas within the United States (MRID: 43934414). One thousand five hundred and five (1,505) wells were sampled during the period September 1992 to March 1995 in areas that were considered to be susceptible to groundwater contamination and where extensive atrazine has been used.

Nineteen states were selected for monitoring based on high atrazine use and include: FL, HI, IL, IN, IA, KS, KY, LA, MD, MI, MN, MS, OH, PA, TX, VA, WA, WV, and WI. Along with atrazine, the following major degradation products of atrazine were monitored: deethylatrazine (G-30033), deisopropylatrazine (G-28279), diaminochlorotriazine (G-28273), hydroxyatrazine (G-34048), deethylhydroxyatrazine (GS-17794), deisopropylhydroxyatrazine (GS-17792), and diaminohydroxyatrazine (GS-17791).

Atrazine and the chlorotriazine degradates were analyzed by a gas chromatography-mass spectrometry (GC/MS) method, and the hydroxytriazine degradates were analyzed by liquid chromatography-mass spectrometry (LC/MS). The limit of determination (LOD, equivalent to limit of quantitation (LOQ) for all the analytes was established as 0.10 ppb.

The total number of wells sampled in each state ranged from 28 (Texas) to 200 (Wisconsin). Well selection and sampling were typically conducted in cooperation with the state's Departments of Agriculture or in some cases, other affiliates such as land grant universities. These wells were not selected at random but rather the well selection was highly biased for positive detections of atrazine and its degradation products due to high groundwater vulnerability and previous detections of atrazine in a large number of wells. The results of this monitoring study still pose some uncertainties, since not all surveyed wells were monitored. For example, in the State of Indiana, the number of wells started at 886, and ultimately 93 wells were selected. Also the fact that many wells selected for sampling penetrated shallow aquifers
(less than 50 feet below land surface) suggests that not all monitoring wells were limited to shallow aquifers.

In this monitoring program, one water sample was analyzed for each well. This study represents the private and individual wells which are not required to provide monitoring data under the regulatory framework established by the SDWA (Safe Drinking Water Act). Novartis has also submitted the CWSs (community water systems) for groundwater sources as part of its PLEX (Population-Linked Exposure) drinking water assessment.

5.2 Results of the Rural Well Survey

The maximum values of atrazine and its degradates for each of the nineteen states are tabulated in Table 5-1. The maximum, 99th percentile, 95th percentile and 90th percentile values for each analyte and the sums of chloro- and hydroxy- metabolites are summarized in Table 5-2. The associated cumulative exceedence curves for each analyte are presented in Figures 5-1 to 5-4.

Total chloro-triazine concentrations were substantially higher than total hydroxy-triazine concentrations. The maximum, 99th percentile, and 95th percentile total chloro-triazine concentrations were 18.0, 6.97, and 3.6 ug/L, respectively, compared to maximum, 99th percentile, and 95th percentile total hydroxy-triazine concentrations of 7.66, 0.57, and 0.17 ug/L.

The maximum concentrations of atrazine (12.0 ug/L) and DACT (10 ug/L) were comparable and larger than those for hydroxy-atrazine (6.5 ug/L), DEA (5.0 ug/L), and DIA (1.9 ug/L). The 99th and 95th percentile concentrations of atrazine, DEA, and DACT were comparable but substantially greater than those percentile concentrations for DIA or hydroxy-atrazine. The other hydroxy-triazine analytes were detected much less frequently and at much lower concentrations than hydroxy-atrazine, atrazine, DEA, DIA, and DACT.

5.3) Comparison of atrazine concentrations to the MCL and short term HAL and of total chloro-triazines and total hydroxy-triazines to HED DWLOCs

Eight wells (out of the 1,505 wells) had atrazine concentrations exceeding the MCL of 3 ug/L. The highest atrazine concentration detected (12 ug/L) was much less than the short term HAL of 100 ug/L.

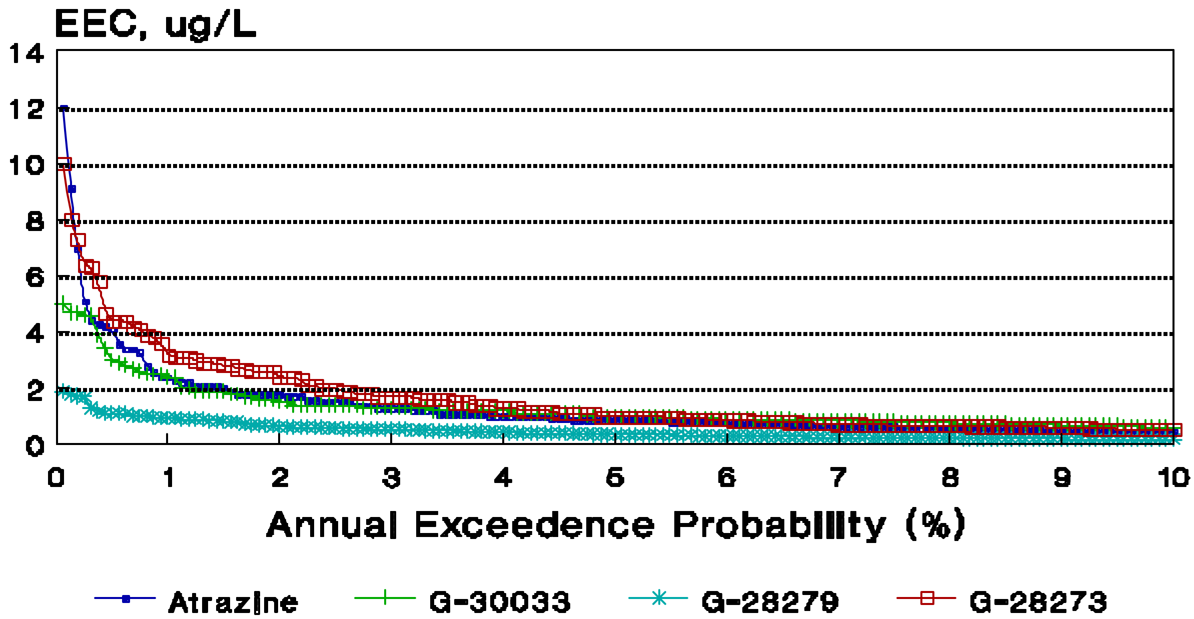
One well had a total chloro-triazine concentration equaling the HED sub-chronic/chronic DWLOC of 18 ug/L for children and infants. No wells had total chloro-triazine concentrations exceeding the HED sub-chronic/chronic DWLOC of 18 ug/L for children and infants, the HED sub-chronic/chronic DWLOC of 63 ug/L for adults or the single HED acute DWLOC of 298 ug/L for adult women.

The highest total hydroxy-triazine concentration detected (7.66 ug/L) was much less than the HED chronic DWLOC of 99 ug/L for children and infants.

5.5) Scatter plots of the sum of degradate versus atrazine concentrations in ground water

To determine if it was possible to develop regression equations relating degradate to atrazine concentrations, scatter plots of total chloro-triazine degradates versus atrazine (Figure 5-5) and total hydroxy-triazine degradates versus atrazine (Figure 5-6) were generated. The lack of correlation between the sum of degradate concentrations and atrazine concentrations in the figures indicates that the development of regression equations from this set of ground water data is not possible.

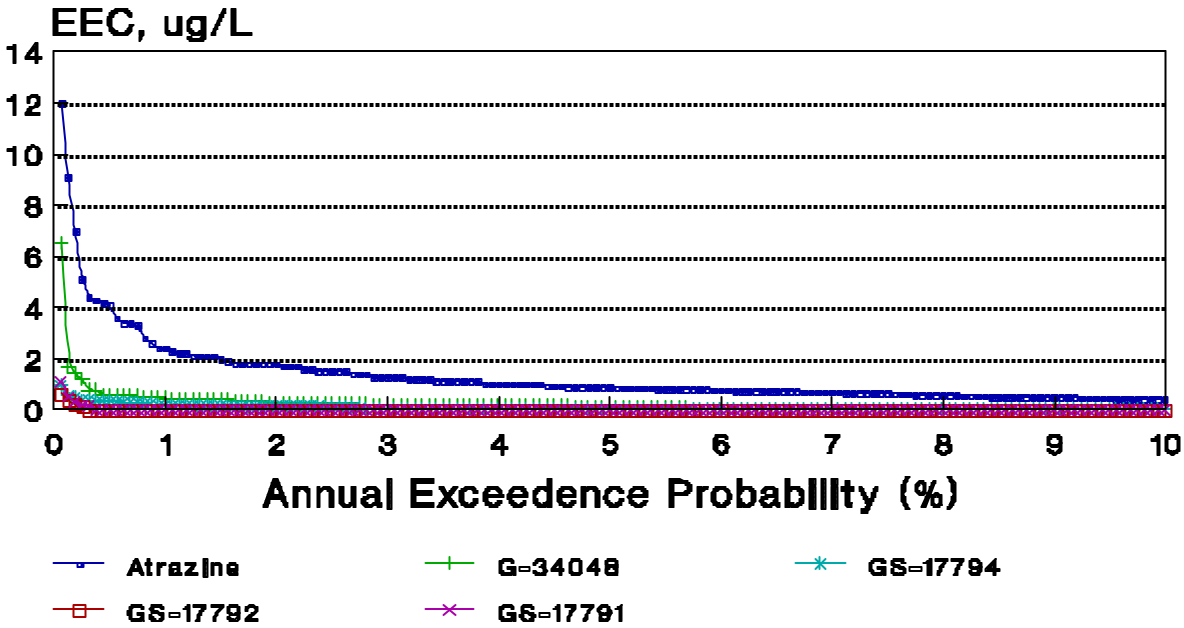
Fig 5-1. Cumulative Exceedence Curves
Ciba/State GW Monitoring Study
19 States (1505 Wells) 09/92 to 03/95



Concentration Percentiles (ug/L)

	90th	95th	99th	maximum
Atrazine	0.42	0.87	2.4	12.0
G-30033	0.61	1.0	2.4	5.0
G-28279	0.17	0.35	0.93	1.9
G-28273	0.52	1.0	3.2	10.0

Fig 5-2. Cumulative Exceedence Curves
Ciba/State GW Monitoring Study
19 States (1505 Wells) 09/92 to 03/95



Concentration Percentiles (ug/L)

	90th	95th	99th	maximum
Atrazine	0.42	0.87	2.4	12.0
G-34048	–	0.11	0.45	6.5
GS-17794	–	–	0.19	0.96
GS-17792	–	–	--	0.64
GS-17791	–	–	–	1.1

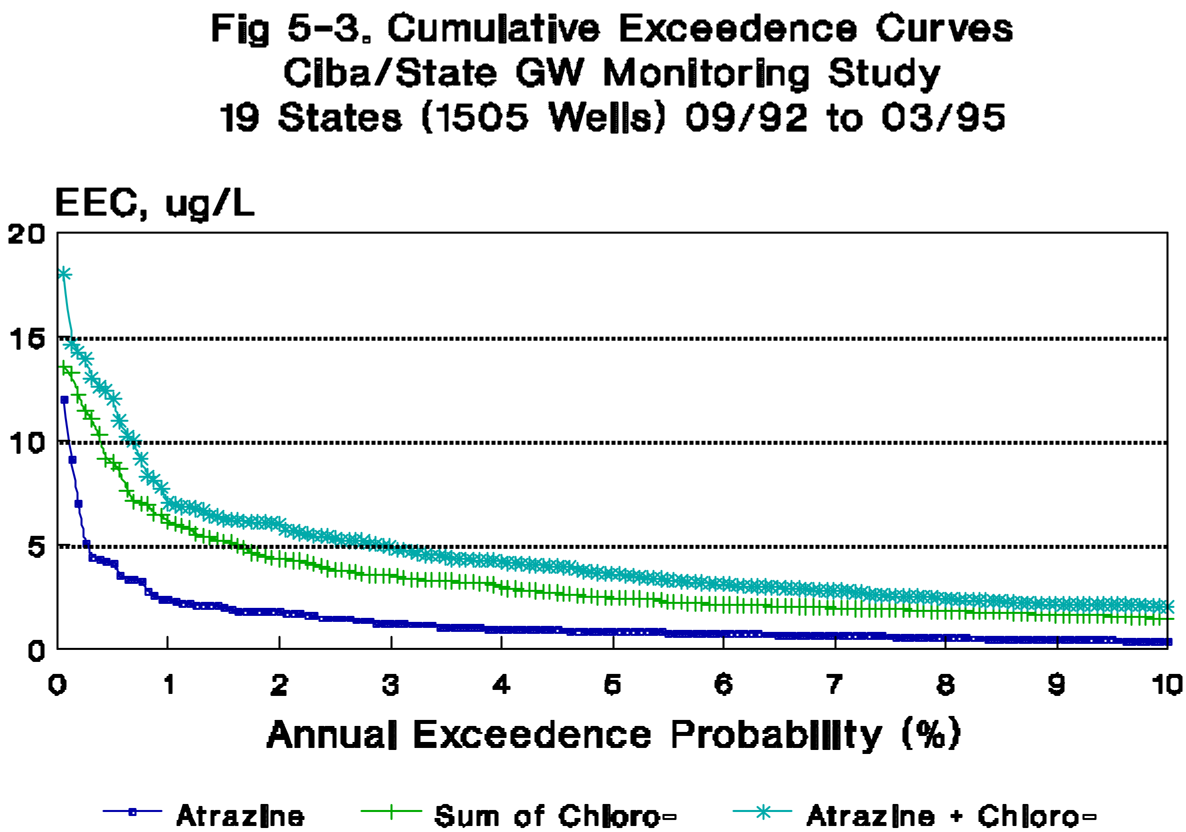


Fig 5-3. Cumulative Exceedence Curves
Ciba/State GW Monitoring Study
19 States (1505 Wells) 09/92 to 03/95
EEC, ug/L
20
15
10
5
0
0
1
2
3
4
5
6
7
8
9
10
Annual Exceedence Probability (%)
Atrazine
Sum of Chloro-
Atrazine + Chloro-

Concentration Percentiles (ug/L)

	90th	95th	99th	maximum
Atrazine	0.42	0.87	2.4	12.0
Sum of Chloro-	1.47	2.45	6.1	13.5
Atrazine + sum of Chloro-	2.0	3.6	6.97	17.98

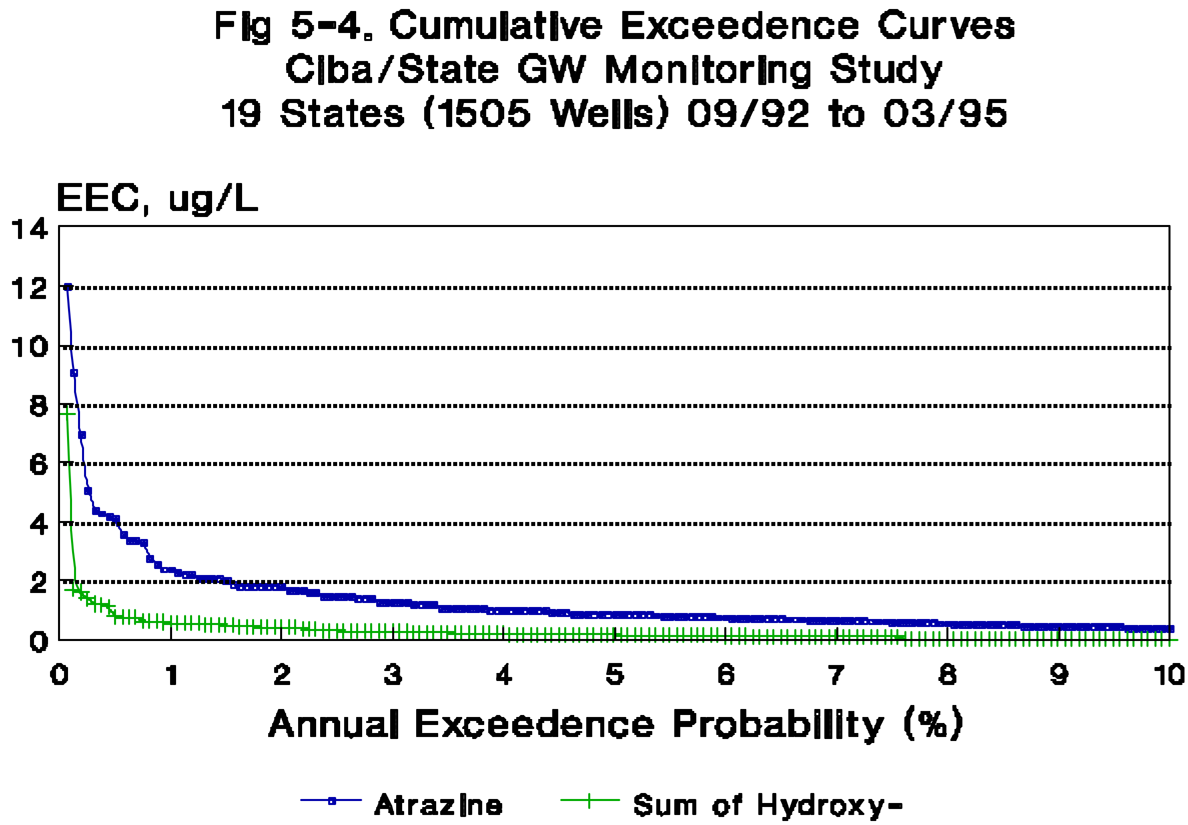
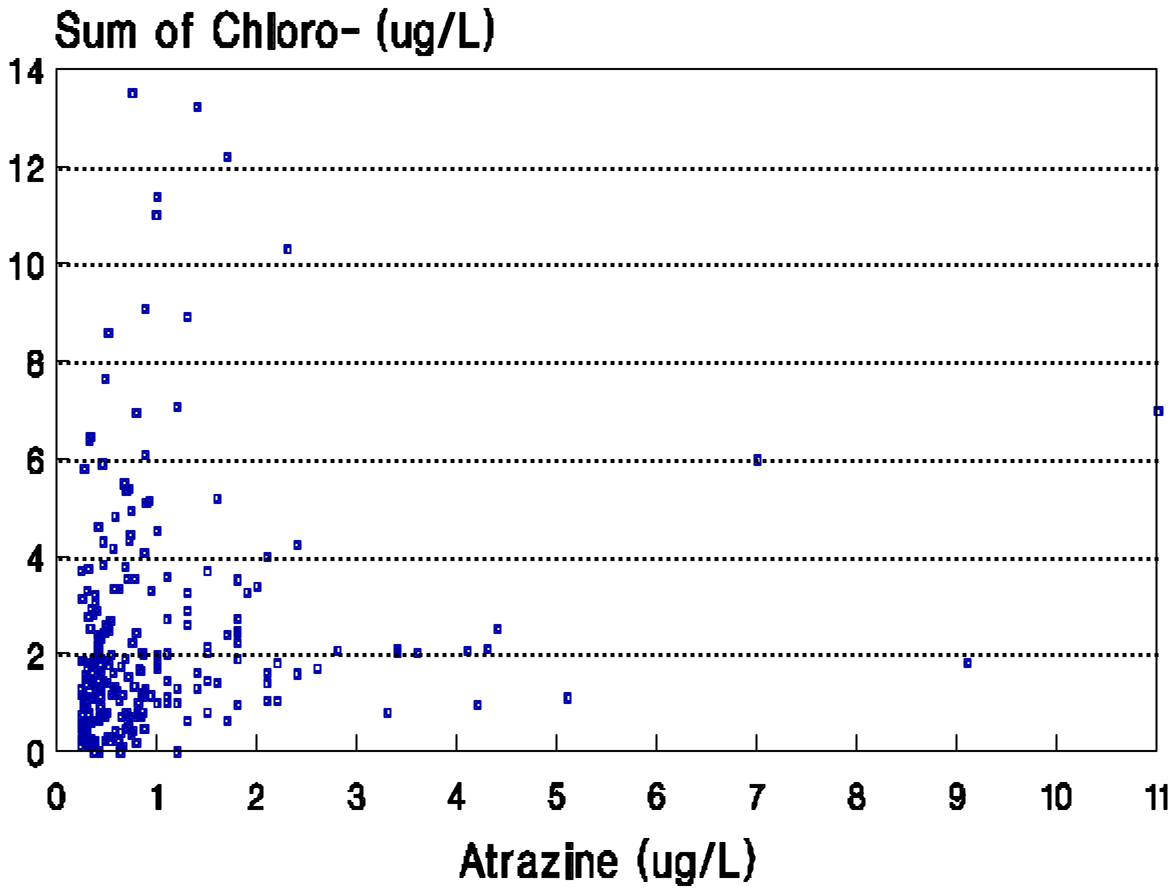


Fig 5-4. Cumulative Exceedence Curves
Ciba/State GW Monitoring Study
19 States (1505 Wells) 09/92 to 03/95
EEC, ug/L
14
12
10
8
6
4
2
0
0
1
2
3
4
5
6
7
8
9
10
Annual Exceedence Probability (%)
Atrazine
Sum of Hydroxy-

Concentration Percentiles (ug/L)

	90th	95th	99th	maximum
Atrazine	0.42	0.87	2.4	12.0
Sum of Hydroxy-	0.0	0.17	0.57	7.66

Fig 5-5. Atrazine to Sum of Chloro-Meta.
Regression Results: r2 = 0.087
Sum of Chloro- = 0.581*Atrazine + 1.232



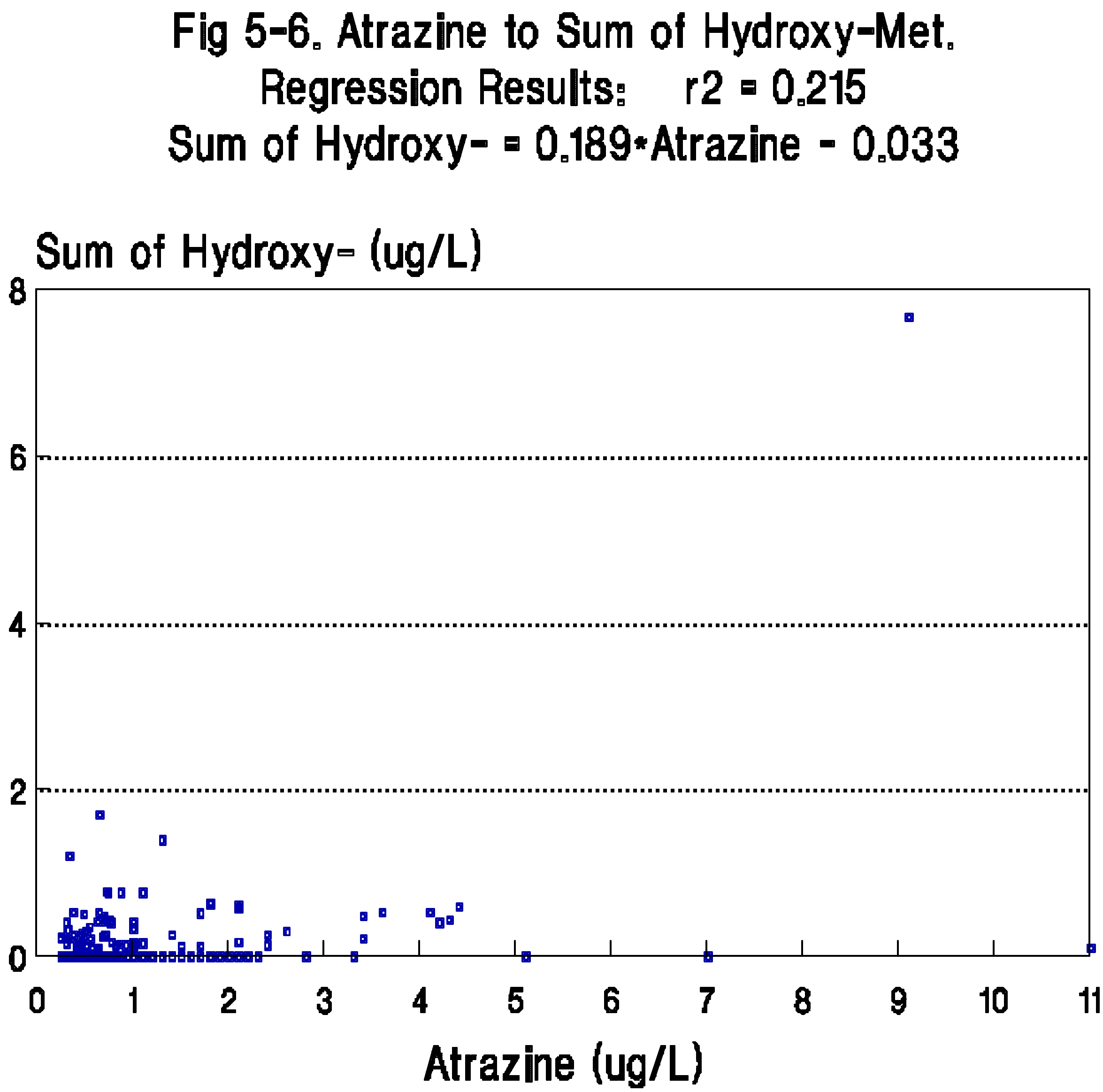


Fig 5-6. Atrazine to Sum of Hydroxy-Met.
Regression Results: r2 = 0.215
Sum of Hydroxy- = 0.189*Atrazine - 0.033
Sum of Hydroxy- (ug/L)
8
6
4
2
0
0
1
2
3
4
5
6
7
8
9
10
11
Atrazine (ug/L)

Table 5-1. Maximum measured values of atrazine and its degradates for each of nineteen states based on Ciba/State groundwater monitoring study from September 1992 to March 1995

State	Atrazine	G-30033	G-28279	G-28273	G-34048	GS-17794	GS-17792	GS-17791
FL	0.25	0.28	0.11	0.26	0.25			
HI	1.80	1.50	0.53	0.47	1.20	0.20		
IA	1.30	1.20	0.71	0.98	0.11			
IL	1.80	1.90	0.53	0.99	0.52	0.12		
IN	9.10	1.90	0.43	0.46	6.50	0.96	0.20	
KS	5.10	1.10	0.32	0.52	1.40	0.19		
KY	0.36	0.52		0.16				
LA					0.58	0.37	0.36	0.31
MD	1.30	3.90	0.83	4.40	0.18	0.11	1.10	
MI	2.20	1.10	1.20	4.10	0.27	0.22		
MN	3.40	1.40	1.70	1.70	0.21			
MS	0.60	0.20						
OH	1.30	0.59	0.41	0.99	0.41	0.12		
PA	1.80	5.00	1.10	7.30	0.14	0.12	0.64	0.50
TX								
VA	0.61	0.86	0.50	2.40				
WA	0.22	0.55	0.24	0.26				
WI	12.00	4.70	1.90	8.00	0.44	0.54		0.14
WV	4.20	3.30	1.20	10.00	1.70	0.11		

Table 5-2. The maximum, 99th percentile, 95th percentile, and 90th percentile values based on Ciba/State Groundwater Monitoring Study, which including samples from 19 states and period from September 92 to March 1995

Unit: ug/L

Analyte	Maximum	99th Percentile	95th Percentile	90th Percentile
Atrazine	12.0	2.4	0.87	0.42
G30033 (DEA)	5.0	2.4	1.0	0.68
G28279 (DIA)	1.9	0.93	0.38	0.18
G28273 (DACT)	10.0	3.6	1.2	0.63
3 Chloro-metabolites	13.5	6.1	2.45	1.46
G34048	6.5	0.45	0.11	-*
GS-17794	0.96	0.190	-	-
GS-17792	0.64	-	-	-
GS-17791	1.1	-	-	-
3 Hydroxy-metabolites	7.66	0.57	0.17	-

Chloro-metabolites: G30033 - deethylatrazine (DEA), G28279 - deisopropylatrazine (DIA), and G28273 - diaminochloroatrazine (DACT).

Hydroxy-metabolites: G34048 - hydroxyatrazine, GS-17794 - deethylhydroxyatrazine, GS-17792 - deisopropylhydroxyatrazine, and GS-17791 - diaminohydroxyatrazine.

* indicates that the available monitoring data can not establish the percentile values due to many samples of below detection limits.

6. Novartis Voluntary Monitoring Study of Atrazine in Surface Water Source CWSs

6.1) Description of the Novartis Voluntary Monitoring Study (VMS)

In a comprehensive update document dated 12/13/99, Novartis supplied all of the data on atrazine that they had collected in their Voluntary Monitoring Study of various surface water source CWSs from 1993 through 1998. In addition, Novartis computed annual (time weighted) atrazine means for all of the years and CWSs monitored. They also supplied multiple year time series plots of atrazine concentrations in all of the CWSs.

Table 6-1 (from the Novartis report) lists the number of sites (CWSs) monitored in each year from 1993 through 1998 in each of the 8 states covered in the study. The number of CWSs monitored increased from 20 in 1993 to 94 in 1998. Of the 94 CWSs monitored in 1998, 31 were in MO, 24 were in IL, 19 were in IA, 4 were in TX, 3 were in LA, 2 were in KS, and 2 were in OH.

The CWSs selected for monitoring were primarily those with current or past problems with atrazine contamination, or previous draw water from small reservoirs that drain agricultural watersheds with a history of substantial atrazine use. However, some of the CWSs employed activated carbon treatment for taste/odor control and/or for decreasing the concentrations of toxics.

Most CWSs were sampled weekly during May, June, and July, and twice per month during other months to give 30 samples per year. Finished water was sampled at all of the CWSs. In addition, raw water was sampled at CWSs employing activated carbon treatment..

Analytical methods were discussed in a 10/29/96 report (MRID 441521-23) submitted by Novartis. The samples were analyzed using a triazine immunoassay, but 10% of the samples were also analyzed for atrazine using GC chromatography.

The triazine immunoassay has a much greater specificity for atrazine than other triazines such as simazine, cyanazine, and various triazine ring degradates. Therefore, the triazine determination by immunoassay reflects primarily atrazine as opposed to other triazines. However, because of cross-reactivity with other triazines, the reported triazine concentrations are slightly greater than the actual atrazine concentrations. To estimate atrazine concentrations from the immunoassay determined triazine concentrations, the atrazine concentrations determined by GC for 10% of the samples were regressed against the corresponding immunoassay determined triazine concentrations. The resulting linear regressions had high r^2 values and were used to estimate atrazine concentrations from immunoassay determined triazine concentrations.

6.2) General Results of the Novartis Voluntary Monitoring Study

EFED generated statistical summaries of 1993-1998 annual mean and annual maximum atrazine concentrations in finished water (from VMS data) are presented in Table 6-2. The 1993-1998 annual mean and annual maximum atrazine concentrations in finished water (from VMS data) are listed in Table 6-3 for each of the monitored CWSs along with the population served by each of the CWSs.

The EFED ranked the data supplied by Norvatis. The EFED then generated cumulative exceedence curves and used interpolation to calculate various percentiles for the 1993-1998 annual mean and maximum atrazine concentrations. EFED generated cumulative exceedence curves for annual mean and annual maximum atrazine concentrations in finished water (upon which statistical summary Table 6-2 is based) are provided Sub-Appendices B-1 and B-2, respectively, of Appendix B.

Novartis generated time series curves are included in Sub-Appendix B-3 for the 15 CWSs having at least one annual mean atrazine concentration $\geq$ 3 ug/L. Novartis generated time series curves are also included in Sub-Appendix B-4 for 15 additional CWSs which (based upon raw water data) would have had one or more finished water annual mean $\geq$ 3 ug/L if activated carbon treatment were not employed.

EFED generated statistical summaries of regression estimated, 1993-1998 annual mean, annual maximum quarterly mean and annual maximum total chloro-triazine concentrations in finished water are presented in Table 6-4, 6-5, and 6-6, respectively. EFED generated cumulative exceedence curves and corresponding tables for annual mean, annual maximum quarterly mean, and annual maximum total chloro-triazine concentrations in finished water (upon which statistical summary Tables 6-4, 6-5, and 6-6 are based) are provided in Sub-Appendices B-5, B-6, and B-7, respectively, of Appendix B.

The percentiles and corresponding exceedence percentiles in statistical summary tables 6-2, 6-4, 6-5, and 6-6 (as well as the cumulative exceedence graphs and tables upon which they are based) are with respect to the % of the assessed CWSs, not the % of the assessed population. The reason is that with a database with a small number of CWSs, one or two CWSs with much larger populations than the other CWSs in the database greatly skew cumulative exceedence curves. An example of that is provided by Figures 3-9 and 3-10 where the population based cumulative exceedeence curve (Figure 3-10) is greatly skewed compared to the CWS based cumulative exceedence curve (Figure 3-9).

6.3) 1994-1998 annual mean atrazine concentrations (from data in the Novartis Voluntary Monitoring Study) and comparison to the Office of Drinking Water MCL for atrazine

All of the numbers described in this section were taken from Table 6-2.

The highest annual mean atrazine concentrations for 1998, 1997, 1996, 1995, and 1994 were 6.64, 4.45, 13.2, 5.21, and 9.35 ug/L, respectively. The 95th percentile annual mean atrazine concentrations for those years were 2.56, 2.92, 6.45, 2.60, and 6.99 ug/L, respectively.

The number of monitored CWSs for which an annual mean could be computed in 1998, 1997, 1996, 1995, and 1994 were 88, 86, 83, 78, and 59 CWSs, respectively. Although some monitoring was done in 1993, the time series are inadequate to compute annual means for that year.

The # of CWSs and % of assessed CWSs with 1998, 1997, 1996, 1995, and 1994 annual mean atrazine concentrations in finished water $\geq$ the atrazine MCL of 3 ug/L were 3 (3/88 = 3.4%), 4 (4/86 = 4.7%), 6 (6/83 = 7.2%), 2 (2/78 = 2.6%), and 8 (8/59 = 14%), respectively.

The identities of, and populations served by, CWSs with annual mean atrazine concentrations $\geq$ the atrazine MCL of 3 ug/L can be obtained from Table 6-3 (See Section 6.5).

6.4) 1993-1998 annual maximum atrazine concentrations (from data in the Novartis Voluntary Monitoring Study) and comparison to Office of Drinking Water short term HALs for atrazine

All of the numbers described in this section were taken from Table 6-2.

The highest annual maximum atrazine concentrations for 1998, 1997, 1996, 1995, 1994, and 1993 were 23.1, 39.3, 39.1, 32.6, 63.7, and 44.1 ug/L, respectively. The 95th percentile annual maximum atrazine concentrations for those years were 12.8, 12.4, 23.9, 9.80, 22.2, and (could not be computed for 1993) ug/L, respectively.

The highest atrazine concentration (63.7 ug/L) reported in the Novartis Voluntary Monitoring study from 1993 through 1998 is well below the Office of Drinking Water short term HALs for atrazine of 100ug/L.

6.5) CWSs with one or more 1994-1998 individual annual mean atrazine concentrations > 3 ug/L

Table 6-3 lists the 1993-1998 annual mean and annual maximum atrazine concentrations for each of the monitored CWSs. Individual annual mean atrazine concentrations $\geq$ 3 ug/L are shaded. It can be seen from Table 6-3 that of the 100 CWSs in the VMS, 15 have one or more 1994-1998 individual annual mean atrazine concentrations $\geq$ 3 ug/L. None of the CWSs had an annual maximum atrazine concentration $\geq$ the short term HAL of 100 ug/L. Therefore, none of the maximum concentrations in Table 6-3 are shaded to reflect exceedences of the HAL.

Time series plots of finished and in some cases raw atrazine concentrations versus time (generated by Novartis) are provided in Sub-Appendix B-3 for the 15 CWSs having one or more finished annual mean atrazine concentrations $\geq$ 3 ug/L.

6.6) Importance of activated carbon treatment in reducing or eliminating non-compliance with the SDWA

Of the 15 CWSs having one or more finished annual means $\geq$ 3 ug/L, the raw water results indicate that 10 would have had one or more additional finished annual means $\geq$ 3 ug/L without activated carbon treatment. The 10 CWSs in question are ADGPTV IL, Carlinville IL, Highland IL, Hillsboro IL, Palmyra IL, Pittsfield IL, Salem IL, Springfield IL, Iberville LA, and Vandalia MO. The substantial (several fold) reduction in atrazine concentrations in those systems with the use of activated carbon treatment can be seen from a comparison of the raw and finished water time series for each CWS.

Time series are also provided in the Appendix B-4 for 15 CWSs which (based upon raw water data) would have had one or more annual means $\geq$ 3 ug/L without activated carbon treatment. The 15 CWSs in question are Carthage IL, Holiday Shores IL, Nashville IL, Belleville IL, Vermont IL, Wayne City IL, Greensburg IN, Centerville IA, Fairfield IA, Lamoni IA, Osceola IA, Edina MO, Monroe City MO, Queen City MO, Unionville MO, and Wyconda MO. As before, the substantial (several fold) reduction in atrazine concentrations in those systems with the use of activated carbon treatment can be seen from a comparison of the raw and finished water time series for each CWS.

6.7) Regression estimated, 1994-1998 annual mean total chloro-triazine concentrations (from data in the Novartis Voluntary Monitoring Study) and comparison to HED sub-chronic/chronic DWLOCs for total chloro-triazines

All of the numbers described in this section were taken from Table 6-4.

The regression estimated, highest annual mean total chloro-triazine (atrazine + DEA + DIA + DACT) concentrations for 1998, 1997, 1996, 1995, and 1994 were 9.66, 6.55, 18.9, 7.6, and 13.5, respectively. The 95th percentile annual mean total chloro-triazine concentrations for those years were 3.68, 4.29, 8.75, 3.93, and 10.2 ug/L, respectively.

The # of CWSs and % of assessed CWSs with 1998, 1997, 1996, 1994, and 1994 annual mean total chloro-triazine concentrations in finished water $\geq$ the HED sub-chronic/chronic DWLOC of 18 ug/L for children and infants were 0 (of 94), 0 (of 90), 2 (2/88 = 2.3%), 0 (of 85), and 0 (of 59), respectively.

The identities of, and populations served by CWSs with annual mean total chloro-triazine concentrations $\geq$ the HED sub-chronic/chronic DWLOC of 18 ug/L for children and infants can be obtained from the cumulative exceedence tables in Sub-Appendix B-5.

The regression estimated, highest annual mean total chloro-triazine concentration (24.8 ug/L) in the Novartis Voluntary Monitoring study from 1994 through 1998 is below the HED sub-chronic/chronic DWLOC of 63 ug/L for adults.

6.8) Regression estimated, 1993-1998 annual maximum quarterly mean total chloro-triazine concentrations (from data in the Novartis Voluntary Monitoring Study) and comparison to HED sub-chronic/chronic DWLOCs for total chloro-triazines

All of the numbers described in this section were taken from Table 6-5.

The “annual maximum” quarterly means for CWSs in all years except 1993 were calculated for May-July. Due to no data prior to late June 1993, the “annual maximum” quarterly means for 1993 were calculated for July-September.

The regression estimated, highest annual maximum quarterly mean total chloro-triazine (atrazine + DEA + DIA + DACT) concentrations for 1998, 1997, 1996, 1995, 1994, and 1993 were 19.3, 16.8, 39.1, 8.88, 42.5, and 61.6 ug/L, respectively. The 95th percentile annual maximum quarterly mean total chloro-triazine concentrations for those years were 7.51, 9.06, 14.2, 7.05, 19.3, and 61.6 ug/L, respectively.

The # of CWSs and % of assessed CWSs with 1998, 1997, 1996, 1995, 1994, and 1993 quarterly mean total chloro-triazine concentrations in finished water $\geq$ the HED sub-chronic/chronic DWLOC of 18 ug/L for children and infants were 1 (1/94 = 1.1%), 0 (of 90), 2 (2/88 = 2.3%), 0 (of 85), 3 (3/59 = 5.1%), and 7 (7/19 = 37%), respectively.

The identities of, and populations served by CWSs with quarterly mean total chloro-triazine concentrations $\geq$ the HED sub-chronic/chronic DWLOC of 18 ug/L for children and infants can be obtained from the cumulative exceedence tables in Appendix B-6.

The regression estimated, highest annual maximum quarterly mean total chloro-triazine concentration (42.5 ug/L) in the Novartis Voluntary Monitoring study from 1993 through 1998 is below the HED sub-chronic/chronic DWLOC of 63 ug/L for adults..

6.9) Regression estimated, 1993-1998 annual maximum total chloro-triazine concentrations (from data in the Novartis Voluntary Monitoring Study) and comparison to HED acute DWLOCs for total chloro-triazines

All of the numbers described in this section were taken from Table 6-6.

The regression estimated, highest annual maximum total chloro-triazine (atrazine + DEA + DIA + DACT) concentrations for 1998, 1997, 1996, 1995, 1994, and 1993 were 32.3, 60.5, 54.7, 45.6, 89.0, and 61.6 ug/L, respectively. The 95th percentile annual maximum total chloro-triazine conentrations for those years were 18.2, 18.1, 29.4, 13.7, 25.1, and 61.6 ug/L, respectively.

The regression estimated, highest annual maximum total chloro-triazine concentration (89.0 ug/L) in the Novartis Voluntary Monitoring study from 1993 through 1998 is well below the single HED acute DWLOC (for women) of 298 ug/L.

Table 6-1 Number of Atrazine Voluntaru Monitoring Sites
In Nine Major Use States

State	# of Sites 1993	# of Sites 1994	# of Sites 1995	# of Sites 1996	# of Site 1997	# of Site 1998	#of Site 1999
Illinois	19	19	25	24	24	24	29
Indiana	–	–	4	6	8	9	9
Iowa	–	22	22	21	19	19	11
Kansas	1	1	1	1	1	2	5
Kentucky	–	–	–	–	–	–	2
Louisiana	–	–	3	3	3	3	3
Missouri	–	19	32	32	32	31	26
Ohio	–	–	–	–	1	2	10
Texas	–	–	1	1	1	4	5
Total	20	61	88	88	89	94	100

Table 6-2. EFED generated statistical summary of 1993/1994-1998 annual mean and annual maximum atrazine concentrations from Novartis Voluntary Monitoring Study data on surface water sources CWSs. The percentiles are based on the percentages of CWSs with equal or lesser concentration.

Percentile (100 - %)	1998 Means	1997 Means	1996 Means	1995 Means	1994 Means	1998 Maxima	1997 Maxima	1996 Maxima	1995 Maxima	1994 Maxima	1993 Maxima
Highest	6.64	4.45	13.20	5.21	9.35	23.07	39.30	39.13	32.64	63.74	44.12
99 (1)	-	-	-	-	-	-	-	-	-	-	-
95 (5)	2.56	2.92	6.45	2.60	6.99	12.79	12.37	23.93	9.80	22.23	-
90 (10)	1.96	2.36	2.82	1.99	4.22	10.09	7.21	11.78	5.77	13.74	17.71
75 (25)	1.29	1.27	1.85	1.28	1.76	4.61	3.94	5.27	3.64	4.31	14.88
50 (50)	0.57	0.71	0.81	0.70	0.78	2.33	2.08	2.43	1.64	1.60	7.90
CWSs	88	86	83	78	59	89	86	85	82	59	19
Obs. # >=3 ug/L	3	4	6	2	8	-	-	-	-	-	-
Obs. % >=3 ug/L	3.41%	4.65%	7.23%	2.56%	13.6%	-	-	-	-	-	-
Obs. # >=100 ug/L	-	-	-	-	-	0	0	0	0	0	0
Obs. % >=100 ug/L	-	-	-	-	-	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

Atrazine MCL = 3 ug/L

Atrazine short term HAL = 100 ug/L

Table 6-3 Annual means and annual maxima atrazine concentrations from Novartis Voluntary Monitoring Study on surface water source CWSs

CWS		Pop.	1998 Mean	1997 Mean	1996 Mean	1995 Mean	1994 Mean	1998 Max.	1997 Max.	1996 Max.	1995 Max.	1994 Max.	1993 Max.
ADGPTV	IL1	1183	1.45	1.20	2.40	1.29	4.22	12.34	1.77	5.40	3.57	13.74	14.88
Carlinville	IL2	6688	1.16	0.36	8.13	5.21	1.88	5.54	0.63	26.43	14.29	6.19	0.16
Carthage	IL3	2657	0.52	0.86	0.18	0.68		1.70	3.30	0.71	1.42		
Centralia	IL4	14274	2.19	0.92	3.58	0.75	3.84	15.02	1.77	14.52	1.92	14.68	4.12
Coulterville	IL5	1100	0.25	2.34	2.30	0.91	0.65	0.62	4.63	5.00	1.75	1.48	4.50
Danville	IL6	38000	0.80	0.76	0.65			13.23	4.97	8.17	0.82		
Farina	IL7	600	3.77	1.91	2.65	1.65	2.88	8.05	3.30	4.21	2.47	4.31	17.71
Greenfield	IL8	1200	1.96	1.15				4.92	1.70				
Hettick	IL9	250	6.64	3.04	12.93	3.38	6.99	23.07	11.97	39.13	6.59	15.63	12.05
Highland	IL10	7800	0.28	0.22	0.38	0.40	0.67	2.23	0.77	1.67	2.19	5.72	0.07
Hillsboro	IL11	4400	1.14	0.59	1.39	1.97	3.61	6.97	1.03	7.38	4.67	30.72	12.05
HolidaySh	IL12	2142	0.10	0.99	0.93	0.93		0.53	1.97	3.41	1.64		
Kinmundy	IL13	940	0.46	0.79	2.43	1.51	2.29	2.86	2.63	6.59	3.57	8.08	17.71
Mt. Carmel	IL14	8375	0.07	0.06	0.07			0.26	0.17	0.24	0.98		
Mt. Olive	IL15	2150	1.92	1.94	2.92	0.64	0.33	4.47	4.63	5.79	1.97	0.82	1.10
Nashville	IL16	3450	0.19	0.10	0.38	1.04	1.04	0.53	0.63	1.11	2.19	2.23	1.48
Palmyra	IL17	60	1.47	1.00	2.17	2.04	9.35	5.99	3.30	12.94	4.94	22.23	13.93
Pittsfield	IL18	4245	0.26	1.46	4.65	1.98	1.24	1.96	6.63	8.97	3.84	4.78	4.12
Salem	IL19	8000	0.36	0.25	2.25	0.77	9.05	2.50	0.77	24.05	4.94	63.74	44.12
SAVE	IL20	400	1.91	0.98	0.30	2.60	0.32	11.44	3.97	1.83	10.00	1.01	7.90
Shipman	IL21	675	1.33	2.12	13.18	1.32	5.35	4.74	7.97	31.19	2.47	12.80	17.71
Springfield	IL22	125123	0.96	0.66	0.85	0.91		1.96	1.03	1.67	2.19		
Vermont	IL23	806	0.25	0.38	0.81			1.43	0.77	5.00			
Waverly	IL24	1402											2.24
WayneCity	IL25	1424	0.32	0.42	0.17	0.66	0.79	0.71	0.77	0.63	1.09	2.80	12.05
White Hall	IL26	2950			6.90	0.84	0.52			10.56	1.53	1.01	4.78
FortWayne	IN1	184716	0.42	0.70	0.28			6.58	5.31	1.98			
Greensburg	IN2	10500	1.07	2.70				2.77	7.52				
Holland	IN3	1462	0.13	0.36	1.85			0.52	0.60	5.14			
Eagle Cr.			1.37	0.96	1.18			7.55	2.36	2.88	3.79		
Fall Creek			1.08	1.16	0.81			5.99	4.94	2.88	1.87		
White R.			0.91	0.59	0.56			9.50	2.73	3.26	2.01		
White R.N.			0.85	0.82	0.56			11.46	7.15	2.50	1.16		
Indianapolis	IN4	839000	1.05	0.88	0.78			8.63	4.30	2.88	2.21		
Jasper	IN5	11340	0.25					2.08					
Scottsburg	IN6	5520	1.98	0.64				7.55	1.19				

Table 6-3 Annual means and annual maxima atrazine concentrations from Novartis Voluntary Monitoring Study on surface water source CWSs - Continued

CWS		Pop.	1998 Mean	1997 Mean	1996 Mean	1995 Mean	1994 Mean	1998 Max.	1997 Max.	1996 Max.	1995 Max.	1994 Max.
Albia	IA1	3870	0.90	1.28	1.52	0.28	1.07	1.46	2.15	3.33	0.78	2.10
Bloomfield	IA2	2580			0.87	0.55	1.76			1.54	1.42	3.72
Centerville	IA3	5936	1.24	1.52	2.62	0.65	1.30	3.60	3.49	8.85	1.15	3.72
Chariton	IA4	4616	3.61	0.86	1.64	0.50	0.78	11.43	1.24	4.02	0.87	1.50
Clarinda	IA5	5104	0.34	0.23	0.46	0.12	0.35	2.35	1.24	2.64	0.60	1.39
Corning	IA6	1950	0.21	0.20	0.20	0.43	0.68	0.48	0.53	0.43	0.96	1.50
Fairfield	IA7	9955	0.53	0.49	0.74	0.38	0.28	2.00	1.38	1.95	1.33	1.09
Lake Park	IA8	996			0.05	0.16	0.43			0.09	0.42	1.09
Lamoni	IA9	2319	0.77	0.62	2.20	0.64	1.78	3.42	2.36	11.00	1.51	3.72
Lenox	IA10	1303				0.88	0.32				3.51	0.79
Leon	IA11	2047	0.34	0.76	0.76	0.16	0.14	0.75	2.64	1.81	0.69	0.18
Milford	IA12	2170		0.05	0.09	0.23	0.29		0.05	0.30	0.51	0.59
Montezuma	IA13	1651	1.04	1.54	1.64	0.68	0.22	2.53	4.19	3.68	2.79	0.48
Mt.Pleasant	IA14	8027	0.85	0.59	0.33	0.63	1.09	8.58	5.24	2.02	6.25	9.18
Mt. Ayr	IA15	1796	2.03	1.07	2.25	1.66	1.56	8.14	2.01	10.92	3.15	3.11
Okoboji	IA16	25	0.14	0.16	0.18	0.24	0.35	0.22	0.25	0.23	0.51	0.89
Osceola	IA17	4164	0.97	1.26	1.21	0.92	0.64	2.35	3.49	2.64	1.60	1.29
Panora	IA18	1100		0.48	0.47	0.51	0.37		2.78	4.02	2.79	1.60
Rathbun	IA19	22196		0.73	1.62	0.86	1.55	0.93	2.64	2.43	1.33	2.71
Spirit Lake	IA20	3872	0.09	0.06	0.07	0.10	0.25	0.31	0.11	0.16	0.42	0.48
Wahpeton	IA21	484	0.11	0.17	0.19	0.26	0.36	0.22	0.39	0.23	0.60	0.79
Winterset	IA22	4196	0.14	0.39	0.20	0.16	0.97	0.75	1.17	0.71	0.69	2.81
Atchison	KS1	10656	1.55					7.08				
Topeka	KS2	119883	0.50	0.98	1.08	0.71		2.33	5.68	8.46	4.27	
Iberville	LA1	10400	1.30	3.42	2.89	2.63		10.41	28.25	23.64	32.64	
Jefferson	LA2	494441	0.29	0.33	0.57	0.35		1.86	2.18	2.77	1.50	
Thibodaux	LA3	15810	0.64	1.19	0.96	0.79		4.30	23.51	13.78	15.43	
Adrian	MO1	1500	0.93	0.21	0.24	0.32		3.38	0.46	0.49	0.85	
AECI(Cl.Hill)	MO2	105	0.08	0.36	0.43	0.28		0.24	1.09	1.34	0.59	
Baring	MO3	182	2.86	2.40	2.14	0.89	0.82	4.23	3.54	4.51	1.29	1.39
Bates Co(Am)	MO3	230	0.29					0.58				
Brookfield	MO4	4888	0.05	0.06	0.06	0.05		0.05	0.15	0.12	0.05	
Bucklin	MO5	616	0.88	4.45				4.74	12.59	0.05		
Butler	MO6	4100	0.45	0.56	0.57	0.35		1.94	2.04	4.21	8.66	
Cl.Cannon	MO7	25	0.58	0.83	0.85	1.00	2.08	3.38	2.35	4.21	2.52	5.79
Clarence	MO8	1100			0.26	0.08	0.16			0.67	0.33	0.36

Table 6-3 Annual means and annual maxima atrazine concentrations from Novartis Voluntary Monitoring Study on surface water source CWSs - Continued

CWS		Pop.	1998 Mean	1997 Mean	1996 Mean	1995 Mean	1994 Mean	1998 Max.	1997 Max.	1996 Max.	1995 Max.	1994 Max.
Concordia	MO9	2600	1.24	2.69	1.36	2.28		3.97	8.65	3.29	4.27	
Dearborn	MO10	481	0.20	0.20	0.27	1.73		0.66	0.46	1.04	6.03	
Drexel	MO11	1060	0.63	1.00	0.83	1.49		10.09	3.14	1.59	3.40	
Edina	MO12	1283	1.36	1.00	1.72	0.22	0.59	2.36	2.83	10.3	0.85	0.90
Green City	MO13	671				0.16	0.29				0.59	0.60
Hamilton	MO14	1650	0.13	0.29	0.37	1.98		0.75	0.94	0.79	5.15	
Higginsvile	MO15	4693	0.56	1.72	0.84	0.73		1.09	3.93	1.46	1.64	
Jamesport	MO16	600	1.78	0.39	0.73	1.17		13.48	0.78	2.38	3.40	
Kirksville	MO17	17152				0.05	0.09				0.50	0.12
LaBelle	MO18	845	0.70	0.52	1.64	0.48	0.87	2.02	1.57	4.82	1.47	1.75
Lancaster	MO19	855	0.05	0.08	0.05	0.05	0.10	0.05	0.31	0.05	0.05	0.12
LaPlata	MO20	1575	0.16	0.22	0.05	0.06	0.10	0.58	0.62	0.12	0.07	0.12
Lewistown	MO21	502		0.32	0.38	0.06	0.19		1.17	0.79	0.24	0.36
Macon	MO22	5571	1.33	2.12	1.16	0.99	1.16	2.28	3.93	3.29	2.52	2.23
Marceline	MO23	2938	1.57	3.51	2.30	1.73	1.38	3.30	7.08	3.60	2.52	3.14
Moberly	MO24	14050	0.55	0.88	0.60	0.42	0.77	1.26	2.43	2.07	1.12	1.27
Maysville	MO25	1100	0.16	0.24				0.58	0.86			
MonroeCity	MO26	2701	0.34	0.71	0.76	1.28	1.94	1.17	2.12	1.59	4.27	3.98
Odessa	MO27	3695		0.66	0.94	1.57			1.25	2.07	4.27	
Queen City	MO28	743	0.07	0.14	0.15	0.72	4.30	0.24	1.33	0.55	3.83	7.91
Sedalia	MO29	20000	0.55	0.62	0.72			4.48	3.54	2.38	1.20	
Shelbina	MO30	2171	0.05	0.05	0.46	1.22	0.31	0.05	0.07	1.28	4.71	0.66
Smithville	MO31	4365	1.82	2.19	2.71	2.46		3.13	3.54	3.60	4.71	
Trenton	MO32	6129	0.53	0.44	0.17	0.10	0.21	1.60	1.25	0.55	0.33	0.48
Unionville	MO33	1989	0.05	0.27	1.25	0.49	0.48	0.07	1.17	6.65	1.03	0.97
Vandalia	MO34	2683	1.21	2.17				3.64	15.74	0.43		
Wyaconda	MO35	358	1.98	2.64	0.62	0.37	0.79	4.06	4.72	1.95	1.47	2.78
Norwalk	OH1	14800	0.96					2.68				
Somerset	OH2	1500	0.19	0.28				1.35	0.95			
Hillsboro	TX1	7897	0.93					2.98				
Marlin	TX2	6386	0.50	1.49	0.56			1.18	4.45	1.20		
Midlothian	TX3	5750	0.51					1.02				
Waxahachie	TX4	23946	1.36					1.84				

Table 6-4. EFED generated statistical summary of regression estimated, 1994-1998 annual mean total chloro-triazine (atrazine + DEA + DIA + DACT) concentrations from Novartis Voluntary Monitoring Study data on surface water source CWSs. The percentiles are based on the percentages of CWSs with an equal or lesser concentration.

Percentile	Exceedence Percentile					
Year		1998	1997	1996	1995	1994
Highest	-	9.6555	6.5501	18.9292	7.6278	13.4983
95%	5%	3.6779	4.2856	8.7480	3.9289	10.1518
90%	10%	3.0023	3.5369	4.1338	3.0561	6.2240
75%	25%	2.0621	1.9629	2.6790	2.0586	2.7357
50%	50%	1.1404	1.2610	1.3886	1.2255	1.3460
Total CWSs assessed		92	90	87	78	59
Obs. # CWS >= 18 ug/L		0	0	2	0	0
Obs. % CWs >= 18 ug/L		0.0%	0.0%	2.30%	0.0%	0.00%
Obs. # CWS >= 63 ug/L		0	0	0	0	0
Obs. % CWs >= 63 ug/L		0.0%	0.0%	0.0%	0.0%	0.0%

Total chloro-triazine sub-chronic/chronic DWLOC = 18 ug/L for children and infants
Total chloro-triazine sub-chronic/chronic DWLOC = 63 ug/L for adults

Table 6-5. EFED generated statistical summary of regression estimated, 1993-1998 annual maximum quarterly mean total chloro-triazine (atrazine + DEA + DIA + DACT) concentrations from Novartis Voluntary Monitoring Study data on surface water source CWSs. The percentiles are based on the percentages of CWSs with an equal or lesser concentration.

Percentile	Exceedence Percentile						
Year		1998	1997	1996	1995	1994	1993
Highest	-	19.2793	16.8317	39.1484	8.8803	42.4517	61.6103
95%	5%	7.5133	9.0558	14.1521	7.0474	19.2720	61.6103
90%	10%	5.6529	6.4288	8.4817	5.6446	11.6569	24.7947
75%	25%	3.8745	3.0942	5.2852	3.5536	3.9696	20.1876
50%	50%	1.8363	2.1701	2.3895	1.8244	1.6841	9.4226
Total CWSs assessed		94	90	88	85	59	19
Obs. # CWS >= 18 ug/L		1	0	2	0	3	7
Obs. % CWs >= 18 ug/L		1.06%	0.00%	2.27%	0.00%	5.08%	36.84%
Obs. # CWS >= 63 ug/L		0	0	0	0	0	0
Obs. % CWs >= 63 ug/L		0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

Total chloro-triazine sub-chronic/chronic DWLOC = 18 ug/L for children and infants
Total chloro-triazine sub-chronic/chronic DWLOC = 63 ug/L for adults

Table 6-6. EFED generated statistical summary of regression estimated, 1993-1998 annual maximum total chloro-triazine (atrazine + DEA + DIA + DACT) concentrations from Novartis Voluntary Monitoring Study data on surface water source CWSs. The percentiles are based on the percentages of CWSs with an equal or lesser concentration.

Percentile	Exceedence Percentile						
Year		1998	1997	1996	1995	1994	1993
Highest	-	32.2666	60.5485	54.6542	45.6072	88.9606	61.6103
95%	5%	18.1998	18.0802	29.3729	13.6638	25.1377	61.6103
90%	10%	16.0683	11.5362	15.7114	8.4048	20.3154	25.4785
75%	25%	7.5591	6.0385	8.2804	5.8762	6.7703	20.4897
50%	50%	3.5140	3.4785	4.3445	2.9176	2.5670	12.6133
Total CWSs assessed		94	90	88	85	59	19
Obs. # CWS >= 298 ug/L		0	0	0	0	0	0
Obs. % CWs >= 298 ug/L		0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

Total chloro-triazine acute DWLOC is 298 ppb for the subgroup females 13-50

7. ARP Monitoring Study of Atrazine in Surface Water Source CWSs

7.1) Description of the ARP surface water monitoring study

As one of the conditions of registration, the Acetochlor Registration Partnership (ARP) agreed to monitor a number of surface water source Community Water Supplies (CWSs) for acetochlor for several years. However, in addition to analyzing samples for acetochlor, the ARP also analyzed samples for atrazine.

A stratified random sampling methodology was used to select CWSs for sampling and analysis. The ARP developed 60 strata representing 12 states (IL, IN, IA, MN, NE, KS, WI, OH, MO, PA, MD, and DE) X 5 types of water bodies/watersheds (Great Lakes, Continental Rivers; small watersheds with 5-10%, 11-20%, and >20% corn intensity).

Corn intensity was defined by the authors as the % of the total area in the watershed planted to corn. It was estimated using GIS methods and was used as a surrogate for acetochlor usage.

All surface water source CWSs identified in the 12 states that were also willing to cooperate and fit into any of the 60 strata were identified and placed into the applicable stratum as possible candidates for selection. Of the 1,042 surface water CWSs identified across the 12 states, only 306 were possible candidates that were both willing to cooperate and fit into one of the 60 strata.

To ensure that a greater number of selected CWSs had potentially higher than lower acetochlor concentrations, the ARP decided to select a higher percentage of CWSs from waterbodies and watersheds representing potentially higher overall acetochlor concentrations than from those potentially representing lower overall acetochlor concentrations.

The selection process resulted in the stratified random selection of 175 CWSs of 305 candidate CWSs over 12 states for the surface water monitoring program. Of the 175 CWSs selected, the following percentages represented the 5 different waterbody/watershed classes:

(1) 76/175 = 43.4% represented drainage from small watersheds with > 20% corn intensity.

(2) 31/175 = 17.7% represented drainage from small watersheds with 10-20% corn intensity.

(3) 43/175 = 24.6% represented drainage from small watersheds with 5-10% corn intensity.

(4) 17/175 = 9.7% represented intake from continental rivers (Missouri, Mississippi, and Ohio Rivers).

(5) 8/175 = 4.6% represented intake from the Great Lakes

Of the 175 CWSs selected, the following percentages were in the 12 represented states:

(1) 42/175 = 24% in IL
(2) 30/175 = 17.1% in OH
(3) 25/175 = 14.3% in MO
(4) 22/175 = 12.6% in IN
(5) 16/175 = 9.1% in IA
(6) 10/175 = 5.7% in PA
(7) 9/175 = 5.1% in KS
(8) 6/175 = 3.4% in WI
(9) 5/175 = 2.9% in MD
(10) 4/175 = 2.3% in NE
(11) 4/175 = 2.3% in MN
(12) 2/175 = 1.1% in DE

The 12 states represented in the ARP study are all among the 21 states Novartis included in the PLEX database as ones with the highest atrazine use. In addition, the 12 states include all of the ones identified earlier by EFED from Figure 2-1 as having large areas of high atrazine use per unit area.

All of the 175 CWSs selected for the surface water monitoring program employ conventional treatment (coagulation, flocculation, sedimentation, filtration) to remove suspended sediments and other suspended solids from the water supply. In addition, 111 CWSs (111/175 = 63.4%) use powdered activated carbon (PAC) and 21 CWSs (21/175 = 12%) use granular activated carbon (GAC) in place of or in addition to PAC for taste/odor control, and in some cases also to reduce dissolved organics in their water supplies.

7.2) General results from the ARP surface water monitoring study

EFED (RD Jones) computed annual (time weighted) atrazine mean concentrations for all of the years and CWSs monitored. The EFED ranked the annual means and maximums. The EFED (H Nelson) then generated cumulative exceedence curves and used interpolation to calculate various percentiles for the 1995-1997 annual mean and annual maximum atrazine concentrations.

EFED generated statistical summaries of 1995-1997 annual mean and annual maximum atrazine concentrations in finished water (from ARP data) are presented in Table 7-1. The 1995-1997 annual mean and annual maximum atrazine concentrations in finished water (from ARP data) are listed in Table 7-2 for each of the monitored CWSs along with the population served by each of the CWSs.

As was the case for the Novartis Voluntary Monitoring study, the percentiles and corresponding exceedence percentiles in statistical summary Table 7-1 (as well as the cumulative exceedence graphs and tables upon which they are based) are given with respect to the % of the assessed CWSs, not the % of the assessed population.

EFED generated cumulative exceedence curves for annual mean and annual maximum atrazine concentrations in finished water (upon which statistical summary Table 7-1 is based) are provided in the Sub-Appendices C-1 and C-2, respectively, of Appendix C. EFED generated time series curves are included in Sub-Appendix C-3 for the 19 CWSs having a at least one finished water annual mean atrazine concentration $\geq$ 3 ug/L .

EFED generated statistical summaries of regression estimated, 1995-1997 annual mean, annual maximum quarterly mean and annual maximum total chloro-triazine concentrations in finished water are presented in Tables 7-3, 7-4, and 7-5, respectively. EFED generated cumulative exceedence curves and corresponding tables for annual mean, annual maximum quarterly mean and annual maximum total chloro-triazine concentrations in finished water (upon which statistical summary Tables 7-3, 7-4, and 7-5 are based) are provided in Sub-Appendices C-4, C-5, and C-6, respectively, of Appendix C.

<u>7.3) 1995-1997 annual mean atrazine concentrations (from data in the ARP Surface Water Monitoring Study) and comparison to the Office of Drinking Water MCL for atrazine</u>

All of the values described in this section were taken from Table 7-1.

The highest annual mean atrazine concentrations for 1997, 1996, and 1995 were 4.83, 12.3, and 6.41 ug/L, respectively. The 99^{th} percentile annual mean atrazine concentrations for those years were 3.61, 8.71, and 4.90 ug/L, respectively. The 95^{th} percentile annual mean atrazine concentrations for those years were 2.33, 3.70, and 2.51, respectively.

The number of monitored CWSs was 175 for the 1997, 1996, and 1995 annual means.

The # of CWSs and % of assessed CWSs with 1997, 1996, and 1995 annual mean atrazine concentrations in finished water $\geq$ the atrazine MCL of 3 ug/L were 3 (3/175 = 1.71%), 13 (13/175 = 7.43%), and 5 (5/175 = 2.86%), respectively.

The identities of, and populations served by CWSs with annual mean atrazine concentrations $\geq$ the atrazine MCL of 3 ug/L can be obtained from Table 7-2 (See Section 7.5).

<u>7.4) 1995-1997 annual maximum atrazine concentrations (from data in the ARP Surface Water Monitoring Study) and comparison to Office of Drinking Water short term HALs for atrazine</u>

All of the numbers described in this section were taken from Table 7-1.

The highest annual maximum atrazine concentrations for 1997, 1996, and 1995 were 23.1, 49.5, and 18.3 ug/L, respectively. The 99th percentile annual maximum atrazine concentrations for those years were 21.8, 38.2, and 17.1 ug/L, respectively. The 95th percentile annual maximum atrazine concentrations for those years were 8.48, 15.0, and 10.1 ug/L, respectively.

The highest atrazine concentration (49.5 ug/L) reported in the ARP Monitoring study from 1995 through 1997 is well below the Office of Drinking Water short term HALs for atrazine of 100ug/L.

There were 175 monitored CWSs.

7.5) CWSs with one or more 1995-1997 individual annual mean atrazine concentrations > 3 ug/L

Table 7-2 lists 1995-1997 annual mean and annual maximum atrazine concentrations in finished water for each of the monitored CWSs in the ARP Surface Water Monitoring Study. Individual annual means $\geq$ 3 ug/L are shaded. It can be seen from Table 7-2 that of the 175 CWSs listed, 19 have one or more 1995-1997 individual annual mean atrazine concentration $\geq$ 3 ug/L.

7.6) Time series plots

Time series plots of finished atrazine concentrations versus time (generated by EFED) are provided in Sub-Appendix C-3 for the 19 CWSs having one or more finished annual mean atrazine concentration $\geq$ 3 ug/L.

The time series curves for finished water concentrations of atrazine in surface water source drinking water supplies shown in Appendix C-3 somewhat resemble the time series curves generally reported for raw water concentrations of atrazine in flowing natural water. In both types of curves, atrazine concentrations generally increase during mid to late Spring use periods and then decline throughout the summer, fall, and winter until atrazine is applied the following year. However, in some drinking water supplies, the atrazine concentrations remain elevated for a somewhat longer period than they do in flowing natural water. That is evident in a number of systems including Carlinville IL, Greenville IL, Palmyra IL, Pana IL, Pittsfield IL, Shipman IL, Sorento IL, White Hall IL, Holland IN, Scottsburg IN, Marceline MO, and Upper Sandusky OH. That may be due to a combination of longer hydrologic residence times in drinking water reservoirs and the only moderate susceptibility of atrazine to degradation in waters with low microbial activity.

The time series curves provided in Appendix C-3 generally show large variations from year to year (during 1995-1997) within the same water supply. For many of the CWSs, atrazine concentrations during one of the three years of sampling were much greater than those in the other two years. Some of the CWSs had relatively high atrazine concentrations during portions of two of the years, but not during the other year. None of the CWSs had annual means exceeding the MCL of 3 ug/L in all 3 years. In general, atrazine concentrations tended to be highest in 1996, followed by 1995 and then 1997. However, that was not the case for all of the CWSs.

7.7) Regression estimated, 1995-1997 annual mean total chloro-triazine concentrations (from data in the ARP Surface Water Monitoring Study) and comparison to HED chronic DWLOCs

All of the numbers described in this section were taken from Table 7-3.

The regression estimated, highest annual mean total chloro-triazine (atrazine + DEA + DIA + DACT) concentrations for 1997, 1996, and 1995 were 7.08, 17.6, and 9.34 ug/L, respectively. The 99th percentile annual mean total chloro-triazine concentrations for those years were 5.36, 12.6, and 7.19 ug/L, respectively. The 95th percentile annual mean total chloro-triazine concentrations for those years were 3.54, 5.49, and 3.80 ug/L, respectively.

The identities of, and populations served by CWSs, along with their annual mean total chloro-triazine concentrations can be obtained from the cumulative exceedence tables in Sub-Appendix C-4.

The regression estimated, highest annual mean total chloro-triazine concentration (17.6 ug/L) in the ARP Monitoring study from 1995 through 1997 is below the HED sub-chronic/chronic DWLOC of 63 ug/L for adults.

<u>7.8) Regression estimated, annual maximum quarterly mean total chloro-triazine concentrations during 1995-1997 (from data in the ARP Surface Water Monitoring Study) and comparison to HED chronic DWLOCs</u>

All of the numbers described in this section were taken from Table 7-4.

The annual maximum quarterly means for most of the CWSs were calculated for May-July of each year.

The regression estimated, highest annual maximum quarterly mean total chloro-triazine (atrazine + DEA + DIA + DACT) concentrations for 1997, 1996, and 1995 were 14.7, 33.9, and 21.2 ug/L, respectively. The 99th percentile quarterly mean total chloro-triazine concentrations for those years were 12.2, 32.6, and 18.4 ug/L, respectively. The 95th percentile quarterly mean total chloro-triazine concentrations for those years were 7.70, 11.4, and 7.05 ug/L, respectively.

The # of CWSs and % of assessed CWSs with 1997, 1996, and 1995 annual maximum quarterly mean total chloro-triazine concentrations in finished water $\geq$ the HED sub-chronic/chronic DWLOC of 18 ug/L for children and infants were 0 (of 175), 4 (4/175=2.9%), and 1 (1/170=0.6%) CWSs, respectively.

The identities of, and populations served by CWSs with annual maximum quarterly mean total chloro-triazine concentrations $\geq$ the HED sub-chronic/chronic DWLOC of 18 ug/L for children and infants can be obtained from the cumulative exceedence tables in Sub-Appendix C-5.

The regression estimated, highest annual maximum quarterly mean total chloro-triazine concentration (33.9 ug/L) in the ARP Monitoring Study from 1995 through 1997 is below the HED sub-chronic/chronic DWLOC of 63 ug/L for adults.

7.9) 1995-1997 regression estimated, annual maximum total chloro-triazine concentrations from data in the ARP Surface Water Study and comparison to HED acute DWLOCs

All of the numbers described in this section were taken from Table 7-5.

The regression estimated, highest annual maximum total chloro-triazine concentrations for 1997, 1996, and 1995 were 32.3, 69.1, and 31.3 ug/L, respectively. The 99th percentile annual maximum total chloro-triazine concentrations for those years were 30.4, 53.4, and 29.4 ug/L, respectively. The 95th percentile annual maximum total chloro-triazine concentrations for those years were 13.3, 21.8, and 15.2 ug/L, respectively.

The highest estimated annual maximum total chloro-triazine concentration (69.1 ug/L) in the ARP study is well below the single HED acute DWLOC (for women) of 298 ug/L.

Table 7-1. EFED generated statistical summary of 1995-1997 annual mean and annual maximum atrazine concentrations from ARP Monitoring Study data on surface water sources CWSs. The percentiles are based on the percentages of CWSs with equal or lesser concentration.

Percentile (100 - %)	1997 Means	1996 Means	1995 Means	1997 Maxima	1996 Maxima	1995 Maxima
Highest	4.83	12.27	6.41	23.11	49.49	18.28
99 (1)	3.61	8.71	4.90	21.75	38.21	17.12
95 (5)	2.33	3.70	2.50	8.48	14.98	10.11
90 (10)	1.69	2.43	2.14	5.83	11.38	7.37
75 (25)	1.02	1.37	1.06	2.83	4.70	3.58
50 (50)	0.44	0.57	0.43	1.43	1.92	1.48
CWSs	175	175	175	175	175	175
Obs. # >=3 ug/L	3	13	5	-	-	-
Obs. % >=3 ug/L	1.71%	7.43%	2.86%	-	-	-
Obs. # >=100 ug/L	-	-	-	0	0	0
Obs. % >=100 ug/L	-	-	-	0.0%	0.0%	0.0%

Atrazine MCL = 3 ug/L

Atrazine short term HAL = 100 ug/L

Table 7-2. Annual means and annual maxima atrazine concentrations from ARP Voluntary Monitoring Study data on surface water sources CWSs

Site Code	Site Name	Pop. Served	1997 Annual Mean	1996 Annual Mean	1995 Annual Mean	1997 Maximum	1996 Maximum	1995 Maximum
651-NE-DE	Newark	25000	0.05	0.19	0.03	0.18	2.82	0.08
652-WI-DE	Wilmington	93000	0.03	0.19	0.03	0.09	3.51	0.07
544-BL-IA	Bloomfield	3000	1.16	0.93	0.64	1.51	1.56	1.26
577-RA-IA	Centerville	46000	0.79	1.77	0.93	1.00	2.37	1.18
548-CH-IA	Chariton	4660	0.91	1.60	0.49	1.22	3.63	0.07
556-DA-IA	Davenport	125000	0.08	0.12	0.18	0.28	0.35	0.53
557-DM-IA	Des Moines	220000	0.11	0.21	0.11	0.47	0.77	0.43
562-IC-IA	Iowa City	60000	0.24	0.57	0.37	1.11	3.69	1.61
565-LA-IA	Lamoni	2350	0.77	2.22	0.55	1.16	6.62	0.50
566-LE-IA	Lenox	1300	1.09	1.72	0.92	1.53	2.25	3.02
569-MI-IA	Milford	18000	0.02	0.05	0.23	0.03	0.03	0.30
570-MO-IA	Montezuma	4500	1.71	1.72	0.63	3.56	4.09	2.64
571-MA-IA	Mount Ayr	1790	1.17	1.91	1.60	2.18	6.63	2.94
547-CW-IA	Okoboji	2200	0.18	0.22	0.23	0.23	0.24	0.30
574-OS-IA	Osceola	4200	1.37	1.24	0.89	2.90	2.75	1.51
576-PA-IA	Panora	1200	0.57	0.45	0.59	4.18	2.93	2.95
579-SL-IA	Spirit Lake	4300	0.08	0.12	0.20	0.12	0.18	0.28
582-WI-IA	Winterset	4200	0.44	0.25	0.51	1.06	0.57	7.95
170-AL-IL	Altamont	2400	0.96	1.06	0.40	1.91	2.01	1.24
261-AP-IL	Alto Pass	750	0.47	0.83	1.74	1.90	2.91	11.19
601-BL-IL	Blandinsville	750	0.27	0.27	0.28	0.51	0.54	0.52
152-BR-IL	Breese	3625	0.72	1.10	1.27	4.58	4.12	3.33
213-CA-IL	Carlinville	8000	0.38	1.90	4.06	0.58	5.38	9.94
184-CA-IL	Carthage	2800	1.10	0.42	0.99	2.91	0.83	2.00
225-CE-IL	Centralia	14274	0.98					
155-CH-IL	Charleston	20000	0.09	0.06	0.06	0.20	0.16	0.26
159-CH-IL	Chicago	5100000	0.04	0.05	0.04	0.05	0.05	0.05
149-CC-IL	Clay City	1100	0.86	0.21	0.84	1.50	0.32	5.71
242-CO-IL	Coulterville	1100	2.33	2.03	0.99	4.52	5.72	1.82
212-DE-IL	Decatur	89500	0.59	0.95	0.93	2.95	4.19	3.23
197-EL-IL	Elgin	97000	0.03	0.04	0.03	0.06	0.20	0.03
269-FA-IL	Fairfield	7500	0.72	0.75	0.80	2.45	3.28	2.35
172-FA-IL	Farina	575	1.87	2.80	2.33	2.90	3.69	3.30
150-FL-IL	Flora	6630	1.29	2.66	1.58	11.90	22.69	10.26
214-GI-IL	Gillespie	7000	1.45	7.59	1.10	2.97	49.48	2.55
182-GE-IL	Greenfield	1300	1.79	4.22	1.63	4.72	9.70	2.94
222-HI-IL	Highland	10000	0.24	0.62	0.43	0.36	3.04	1.59
603-BL-IL	Hudson	52000	0.26	0.86	0.41	0.81	1.28	1.37
198-KA-IL	Kankakee	61000	0.59	0.49	0.27	5.04	3.64	1.35
233-LI-IL	Litchfield	10000	0.70	1.70	2.12	2.25	11.63	10.07

Table 7-2. Annual means and annual maxima atrazine concentrations from ARP Voluntary Monitoring Study data on surface water sources CWSs. - Continued

Site Code	Site Name	Pop. Served	1997 Annual Mean	1996 Annual Mean	1995 Annual Mean	1997 Maximum	1996 Maximum	1995 Maximum
608-SU-IL	Mascoutah	25000	1.30	3.15	2.38	4.69	11.48	6.63
157-MA-IL	Mattoon	37000	0.43	2.33	1.93	1.43	14.50	7.35
248-MO-IL	Moline	42500	0.11	0.15	0.06	0.84	0.94	0.17
268-NA-IL	Nashville	4500	0.11	0.52	1.21	0.48	1.39	3.00
166-NE-IL	Neoga	1800	0.57	2.28	2.28	1.78	6.00	4.16
606-KA-IL	New Athens	11000	1.13	1.75	1.51	5.54	8.67	5.60
258-NB-IL	New Berlin	370	0.41	0.24	0.20	0.64	0.43	0.32
158-OA-IL	Oakland	996	0.25	0.99	0.46	1.93	8.38	2.22
245-OL-IL	Olney	14000	0.70	1.88	2.24	2.10	2.11	3.58
217-PA-IL	Palmyra	1500	0.84	2.19	3.02	2.82	4.28	3.67
147-PA-IL	Pana	6330	1.48	4.92	3.74	4.00	11.31	5.07
168-PA-IL	Paris	10000	0.93	1.97	0.45	1.78	12.34	1.24
239-PI-IL	Pittsfield	4500	1.48	4.58	2.60	5.85	6.74	5.99
249-RO-IL	Rock Island	48000	0.13	0.21	0.14	1.09	1.67	1.04
228-SA-IL	Salem	12000	0.22	2.27	0.97	0.61	16.61	9.96
219-SH-IL	Shipman	365	2.35	12.27	1.53	7.58	34.65	2.78
143-SO-IL	Sorento	650	1.06	4.03	2.31	1.74	9.90	6.35
244-SP-IL	Sparta	5100	0.83	0.52	0.39	1.90	0.78	0.60
259-SP-IL	Springfield	144000	0.70	1.10	1.37	1.14	1.92	3.60
169-WS-IL	West Salem	1120	1.36	3.13	4.42	3.27	8.81	16.75
183-WH-IL	White Hall	2900		6.49	0.94		12.79	1.55
355-SC-IN	Austin	16680	1.02	1.07	1.20	8.94	8.42	12.28
307-BA-IN	Batesville	6500	4.83	1.83	2.13	9.89	3.29	4.38
310-BO-IN	Borden	7140	0.02	0.03	0.09	0.03	0.93	0.93
344-DU-IN	Dubois	15000	0.34	0.37	0.35	0.50	0.88	1.11
314-EV-IN	Evansville	165000	0.35	0.27	0.46	1.62	1.10	1.82
315-FE-IN	Ferdinand	2963	0.75	0.23	0.36	1.75	0.39	0.83
362-FW-IN	Fort Wayne	200000	0.45	0.32	0.73	2.66	2.52	4.97
320-HO-IN	Holland	895	0.21	2.44	6.41	0.42	7.73	15.30
328-KO-IN	Kokomo	50676	0.83	0.84		3.91	5.17	
330-LO-IN	Logansport	16800	1.68	1.31	0.48	23.11	13.13	3.38
332-MC-IN	Michigan City	37000	0.02	0.02	0.02	0.03	0.03	0.03
334-MI-IN	Mitchell	4700	1.37	1.31	1.22	16.98	15.29	9.18
335-MV-IN	Mount Vernon	3250	0.54	0.45	0.50	2.50	2.80	1.58
340-NV-IN	North Vernon	9056		3.62	1.95		24.84	18.28
341-OC-IN	Oakland City	3300	0.25	0.20	0.09	0.46	0.44	0.15

343-PA-IN	Paoli	5000	0.51	0.77	0.42	2.33	4.44	2.53
345-RI-IN	Richmond	42034	0.45			1.01		
346-SA-IN	Salem	10910		0.53	0.51		0.96	1.01
348-SC-IN	Santa Claus	600		0.34	0.22		0.82	1.05

Table 7-2. Annual means and annual maxima atrazine concentrations from ARP Voluntary Monitoring Study data on surface water sources CWSs. - Continued

Site Code	Site Name	Pop. Served	1997 Annual Mean	1996 Annual Mean	1995 Annual Mean	1997 Maximum	1996 Maximum	1995 Maximum
350-SC-IN	Scottsburg	5500	0.53	5.51	0.11	1.44	14.90	0.17
351-SE-IN	Seymour	16681	0.18			0.88		
352-SP-IN	Speedway	13000	0.68	2.07	2.71	1.76	4.23	5.99
354-SM-IN	St. Meinrad	450	0.04	0.16	0.03	0.03	0.95	0.03
321-WA-IN	Warsaw	8006	0.31	0.30	0.40	0.47	0.43	0.51
359-WE-IN	Westport	1700	0.86	0.81	0.71	1.19	1.59	1.91
25-AT-KS	Atchison	16000	0.35	0.89	0.39	3.62	6.72	3.73
58-GA-KS	Garnett	4300	0.22	0.43	0.15	0.40	0.64	0.22
73-HO-KS	Horton	500	0.76	1.01	0.77	8.13	4.48	8.51
71-KC-KS	Kansas City	166000	0.26	1.09	0.39	2.25	11.77	3.58
77-LE-KS	Leavenworth	50000	0.25	0.63	0.42	1.51	3.91	4.27
89-MI-KS	Milford	500	1.21	1.61	2.49	2.83	4.80	6.45
114-RI-KS	Richmond	525	0.76	0.51	1.10	1.26	1.02	1.73
125-TO-KS	Topeka	140000	1.05	1.19	0.81	4.47	6.89	3.80
129-VF-KS	Valley Falls	1200	1.06	0.81	0.77	5.81	3.77	3.49
696-BA-MD	Bel Air	13100	0.14	0.10	0.22	2.15	0.58	3.78
676-EL-MD	Elkton	7500	0.12	0.11	0.07	2.14	1.01	0.90
684-FR-MD	Frederick	45000	0.15	0.34	0.26	1.20	2.96	2.03
699-HG-MD	Havre de Grace	60000	0.07	0.10	0.10	0.55	0.66	0.43
702-LA-MD	Laurel	470000	0.07	0.30	0.15	0.10	1.00	0.19
279-BB-MN	Beaver Bay	167	0.02	0.02	0.02	0.03	0.03	0.03
277-MI-MN	Minneapolis	500000	0.04	0.03	0.04	0.14	0.13	0.19
275-MO-MN	Moorhead	33000	0.02	0.02	0.03	0.05	0.03	0.07
296-SC-MN	St. Cloud	50000	0.03	0.05	0.09	0.06	0.35	0.54
1039-AR-MO	Armstrong	310	0.17	0.86	1.11	0.55	1.44	2.47
1003-BE-MO	Bethany	3000	0.24	0.48	0.36	0.32	0.74	0.75
1005-BU-MO	Butler	5000	0.56	0.67	0.18	1.52	4.17	0.50
1006-CA-MO	Cameron	9000	2.62	2.38	2.32	3.49	4.70	3.47
1009-CO-MO	Concordia	4000	3.11	1.47	2.42	7.61	3.15	4.50
1046-ED-MO	Edina	2200	0.71	1.50	0.18	2.10	10.57	0.40

1071-EW-MO	Ewing	1000	0.84	1.37	0.05	2.04	2.50	0.20
1035-FR-MO	Freeman	3000	0.08	0.08	0.09	0.17	0.10	0.12
1038-GA-MO	Gallatin	400	0.14	0.16	0.13	0.19	0.25	0.68
1013-GC-MO	Garden City	1325	0.05	0.08	0.03	0.08	0.26	0.06
1098-GE-MO	Gentry	6000	0.18	0.57	0.92	0.35	1.02	1.50
1016-HI-MO	Higginsville	10000	1.58	1.04	1.06	1.44	14.90	0.17
1076-JC-MO	Jefferson City	30000	0.18	0.44	0.55	1.22	1.64	2.90
1053-LA-MO	Labelle	1500	0.35	1.68	0.38	0.62	4.21	0.64
1054-LA-MO	Lancaster	2000	0.06	0.04	0.03	0.11	0.10	0.03
1058-LO-MO	Louisiana	3967	0.43	0.62	0.58	2.27	2.71	1.78

Table 7-2. Annual means and annual maxima atrazine concentrations from ARP Voluntary Monitoring Study data on surface water sources CWSs. - Continued

Site Code	Site Name	Pop. Served	1997 Annual Mean	1996 Annual Mean	1995 Annual Mean	1997 Maximum	1996 Maximum	1995 Maximum
1060-MA-MO	Marceline	2700	3.22	2.42	1.59	4.74	3.46	2.25
1065-MC-MO	Monroe City	3000	0.65	0.86	1.01	2.05	1.46	2.38
1082-PE-MO	Perryville	8000	0.03	0.10	0.05	0.08	1.39	0.19
1066-SH-MO	Shelbina	1022	0.02	0.46	1.06	0.03	1.15	3.03
1032-SM-MO	Smithville	3000	2.12	2.93	2.85	2.86	3.54	3.61
1091-SL-MO	St. Louis	270000	0.29	0.67	0.40	1.07	3.86	1.48
1067-TR-MO	Trenton	8000	0.51	0.26	0.23	1.26	0.47	0.34
1069-VA-MO	Vandalia	3000	2.20	3.34	0.92	9.15	15.39	1.67
1070-WY-MO	Wyaconda	385	2.26	0.82	0.40	4.14	2.23	0.97
305-BL-NE	Blair	7000	0.11	0.28	0.14	0.64	4.04	1.36
304-LC-NE	Hartington	2500	0.06	0.06	0.05	0.14	0.46	0.25
303-OM-NE	Omaha	240000	0.10	0.23	0.13	0.87	3.35	1.03
301-BL-NE	Plattsmouth	2000	0.78	0.76	0.65	1.17	1.28	1.40
371-AL-OH	Alliance	25000	2.67	0.90	0.84	5.12	2.06	2.60
372-AR-OH	Archbold	4920	0.30	0.30	0.28	1.87	0.59	0.84
374-AT-OH	Attica	1200	0.74	0.62	1.22	1.70	1.56	10.64
386-BG-OH	Bowling Green	30000	1.24	1.23	1.42	4.54	5.23	5.30
394-CE-OH	Cedarville	3210			0.12			0.16
395-CE-OH	Celina	9690	0.68	0.13	0.11	2.50	0.33	0.30
400-CM-OH	Cleveland	600000	0.17	0.17	0.08	0.40	0.66	0.12
403-CD-OH	Columbus	269410	0.61	0.57	0.71	1.89	1.33	4.71
408-DE-OH	Defiance	20000	1.36	0.93	1.09	7.66	5.39	10.78
412-DE-OH	Delta	3160	0.09	0.11	0.12	0.12	0.14	0.28

413-EL-OH	E. Liverpool	17600	0.11	0.09	0.17	0.65	0.43	2.61
470-BO-OH	Glouster	14000	0.04	0.08	0.08	0.07	0.15	0.15
443-LI-OH	Lima	74000	0.77	0.58	0.74	1.48	0.95	1.39
451-ML-OH	McClure	860	1.39	1.15	1.32	8.37	6.57	7.72
452-MC-OH	McComb	1700	0.77	0.60	0.81	1.23	0.72	0.96
454-ME-OH	Metamora	950	0.18	0.20	0.18	0.26	0.29	0.35
455-MO-OH	Monroeville	1500	1.73	1.18	1.08	21.32	15.31	9.51
461-NL-OH	New London	5700	0.09	0.10	0.15	0.14	0.11	1.31
485-OT-OH	Ottawa	5000	0.71	0.96	1.01	2.09	2.83	3.51
487-PA-OH	Paulding	3338	1.14			1.66		
506-SO-OH	Somerset	1500	0.23	1.29	0.72	0.60	5.65	3.00
511-SU-OH	Sunbury	2400	0.64	0.51	0.73	1.93	0.75	1.21
518-US-OH	Upper Sandusky	6000	2.44	3.15	1.32	7.06	7.32	3.61
519-VW-OH	Van Wert	11000	1.40	0.46	0.42	3.00	0.75	0.64
527-WE-OH	Wellsville	4530	0.04	0.07	0.05	0.07	0.31	0.13
537-WM-OH	West Milton	4600	1.46	0.63	0.74	15.43	4.77	7.41
530-WE-OH	Westerville	33000	1.39	1.08	1.00	2.75	2.25	1.72

Table 7-2. Annual means and annual maxima atrazine concentrations from ARP Voluntary Monitoring Study data on surface water sources CWSs. - Continued

Site Code	Site Name	Pop. Served	1997 Annual Mean	1996 Annual Mean	1995 Annual Mean	1997 Maximum	1996 Maximum	1995 Maximum
531-WI-OH	Willard	8800	0.17	0.28	0.37	0.21	0.36	0.72
532-WI-OH	Williamsburg	2600	2.13	2.10	2.17	8.16	6.65	7.33
437-LC-OH	Willoughby	80968	0.12	0.05	0.05	0.30	0.13	0.03
534-WI-OH	Wilmington	11199	2.33	2.16	2.03	6.59	3.42	4.27
865-SP-PA	Beavertown	1150	0.02	0.02	0.02	0.03	0.03	0.03
636-CA-PA	Carlisle	6500	0.14	0.15	0.16	0.86	0.44	0.88
596-DE-PA	Denver	3000	0.13	0.12	0.35	2.50	0.70	7.34
593-HE-PA	Hummelston	32000	0.04	0.03	0.04	0.21	0.07	0.13
997-WE-PA	Mechanicsburg	76000	0.11	0.09	0.10	0.36	0.19	0.48
622-NH-PA	New Holland	5000	0.03	0.02	0.02	0.15	0.03	0.03
737-AW-PA	Norristown	82000	0.08	0.08	0.06	0.94	0.26	0.14
729-PH-PA	Phoenixville	22000	0.07	0.11	0.23	0.34	0.67	3.22
769-RE-PA	Reading	85000	0.10	0.11	0.12	0.26	0.38	0.44
730-WC-PA	West Chester	38000	0.02	0.05	0.03	0.05	0.52	0.14
13-AP-WI	Appleton	80000	0.04	0.03	0.02	0.06	0.03	0.03
4-SMI-WI	Cudahy	17500	0.05	0.05	0.05	0.05	0.09	0.06
17-ME-WI	Menasha	85000	0.11	0.06	0.03	0.27	0.11	0.06

7-OC-WI	Oak Creek	24000	0.05	0.05	0.05	0.06	0.06	0.07
18-OK-WI	Oshkosh	57300	0.09	0.09	0.04	0.16	0.25	0.03
10-PW-WI	Port Washington	9500	0.05	0.05	0.05	0.03	0.06	0.06

Table 7-3. EFED generated statistical summary of regression estimated, 1995-1997 annual mean total chloro-triazine (atrazine + DEA + DIA + DACT) concentrations from ARP Monitoring Study data on surface water source CWSs. The percentiles are based on the percentages of CWSs with an equal or lesser concentration.

Percentile	Exceedence Percentile			
Year		1997	1996	1995
Highest	-	7.0847	17.6332	9.3351
99%	1%	5.3572	12.5940	7.1905
95%	5%	3.5374	5.4880	3.7958
90%	10%	2.6401	3.6863	3.2793
75%	25%	1.6906	2.1869	1.7459
50%	50%	0.8682	1.0539	0.8441
Total CWSs assessed		175	175	175
Obs.# CWS >= 18 ug/L		0	0	0
Obs.# CWS >= 63 ug/L		0	0	0

Total chloro-triazine sub-chronic/chronic DWLOC = 18 ppb for children and infants
Total chloro-triazine sub-chronic/chronic DWLOC = 63 ppb for adults

Table 7-4. EFED generated statistical summary of regression estimated, 1995-1997 annual maximum quarterly mean chloro-triazine (atrazine + DEA + DIA + DACT) concentrations from ARP Monitoring Study data on surface water source CWSs. The percentiles are based on the percentages of CWSs with an equal or lesser concentration.

Percentile	Exceedence Percentile			
Year		1997	1996	1995
Highest	-	14.6718	33.8622	21.1575
99%	1%	12.2345	32.5771	18.3947
95%	5%	7.6976	11.4402	7.0537
90%	10%	5.5460	7.8305	5.8041
75%	25%	2.9972	4.3148	3.2606
50%	50%	1.4357	1.9476	1.6474
Total CWSs assessed		175	175	175
Obs.# CWS >= 18 ug/L		0	4	1
Obs.# CWS >= 63 ug/L		0	0	0

Total chloro-triazine sub-chronic/chronic DWLOC = 18 ppb for children and infants
Total chloro-triazine sub-chronic/chronic DWLOC = 63 ppb for adults

Table 7-5. EFED generated statistical summary of regression estimated, 1995-1997 annual maximum total chloro-triazine (atrazine + DEA + DIA + DACT) concentrations from ARP Monitoring Study data on surface water source CWSs. The percentiles are based on the percentages of CWSs with an equal or lesser concentration.

Percentile	Exceedence Percentile			
Year		1997	1996	1995
Highest	-	32.3223	69.0821	31.2789
99%	1%	30.4259	53.3706	29.4170
95%	5%	13.2677	21.8116	15.1961
90%	10%	9.2390	16.1938	11.1827
75%	25%	4.6745	7.0072	5.9153
50%	50%	2.2700	3.1702	2.4027
Total CWSs assessed		175	175	175
Obs.# CWS >= 18 ug/L		0	0	0
Obs.# CWS >= 63 ug/L		0	0	0

Total chloro-triazine acute DWLOC is 298 ppb for the subgroup females 13 - 50

8. Acetochlor Registration Partnership (ARP) Monitoring Study of Atrazine in Ground Water

8.1) Description of the ARP ground water monitoring study

As part of the registration agreement for acetochlor, the ARP has been monitoring observation wells of widely varying screening depths. The ARP has funded acetochlor groundwater monitoring programs in seven major use states (IL, IN, IA, KS, MN, NE, and WI). Although monitoring acetochlor is the main objective, the ARP also monitored other major use chemicals as well, and atrazine is one of them. However, ARP did not monitor any atrazine degradates. The monitoring program includes more than 20 wells for each state with a total of 177 sampling wells in seven states. The sampling frequency is one sample per month per well. The sampling period is from May 1995 to March 1998.

8.2) General results

For each well sampled once per month from May 1995 through March 1998, the EFED computed running 3 month (quarterly) and annual means. Then for each well, the EFED identified a maximum, maximum quarterly mean, and maximum annual mean atrazine concentration. The highest, 99th percentile, 95th percentile and 90th percentile values for each type of concentration are summarized in Table 8-1. The associated cumulative distribution curves are presented in Sub-Appendix D-1 of Appendix D.

The time series plot with all available monthly data was constructed for the temporal effects within the same site. Sub-Appendix D-2 of Appendix D contains the time series plots for three sites (IL, IA, and KS). The plots clearly demonstrate that there is too much change in concentration over time to represent the concentration of any well with only one sample as was done in the Rural Well Survey.

8.3) Comparison of atrazine concentrations to the MCL

All of the values described in this section were taken from Table 8-1.

The highest, 99th percentile, and 95th percentile maximum annual mean atrazine concentrations for the period from May 1995 to March 1998 were 14.3, 5.3, and 0.8 ug/L, respectively. There were two wells (1.13%) out of the total of 177 wells with maximum annual mean atrazine concentrations (14.3 and 4.97 ug/L) greater than the Office of Drinking Water MCL of 3.0 ug/L.

The highest, 99th percentile, and 95th percentile maximum atrazine concentrations for the period from May 1995 to March 1998 were 131.5, 14.5, and 1.5 ug/L, respectively. The 99th percentile annual maximum atrazine concentration for the same period was 14.5 ug/L. One well had a maximum atrazine concentration (132 ug/L) greater than the Office of Drinking Water short term HAL of 100 ug/L. However, the second highest maximum atrazine concentration in a well was 11.0 ug/L which is well below 100 ug/L.

EFED generated time series curves for three wells (IL02, IA01, and KS10) are included in Sub-Appendix D-2. The variations among different months can be significant, which has relevance for the uncertainty in the results of the Rural Well Monitoring Study also, where only one sample was taken for each well.

Table 8-1. The highest, 99th percentile, 95th percentile, and 90th percentile values of atrazine for different time scale based on ARP Groundwater Monitoring Study, which including samples from 7 states and period from May 1995 to March 1998

Unit: ug/L

Duration	Highest	99th Percentile	95th Percentile	90th Percentile
Maximum	131.5	14.5	1.5	0.8
Maximum of Quarterly Mean	55.1	8.7	1.2	0.8
Maximum of Annual Mean	14.3	5.3	0.8	0.5

9. Other Sources/Analyses of Atrazine Data

9.1 Ohio data on atrazine concentrations in surface water source CWSs

The Ohio EPA collected samples from 24 surface water CWSs twice a month from May 1995 through July 1995 and once every three months from September 1995 through March 1996. EFED generated statistical summaries of annual mean and annual maximum atrazine concentrations (based on Ohio EPA data) are provided in Table 9-1. EFED generated cumulative exceedence curves for annual mean and annual maximum atrazine concentrations (upon which statistical summary Table 9-1 is based) are provided in Appendix E.

The highest and 95th percentile annual mean atrazine concentrations were 2.80 and 2.71 ug/L, respectively. Those concentrations are slightly less than the Office of Drinking Water MCL for atrazine of 3 ug/L.

The highest and 95th percentile annual maximum atrazine concentrations were 10.3 and 9.98 ug/L, respectively. Those concentrations are much less than the Office of Drinking Water short term HAL for atrazine of 100 ug/L.

The Kelleher and Pinto 1996 report indicates that Ohio intended to continue sampling those 24 CWSs as well as 126 additional surface water source CWSs through April 1998. The EFED does not currently have the additional data, but will obtain and analyze it for inclusion in a revised drinking water exposure assessment for atrazine.

9.2 Illinois data on atrazine concentrations in surface water source CWSs

The report entitled, "Pre-Compliance Data Testing for Pesticides in Illinois," conducted by the Illinois State Environmental Protection Agency, summarizes the results of finished water samples collected during the Sping and Summer of 1991 and 1992 from 129 surface water supplies in Illinois. That report was attached to an August 8, 1994 6A2 submission by Novartis. The 6A2 submission also had attached some additional data for samples collected in the Summer and Fall of 1992.

Of the 129 CWSs sampled in 1991 and 1992, 37 CWSs (28.7%) had at least one sample with an atrazine concentration > the Office of Drinking Water MCL of 3 ug/L. Individual samples with atrazine concentrations > 3 ug/L do not represent violations of the SDWA because violations occur only if the annual mean atrazine concentration exceeds the MCL. Unfortunately, none of the CWSs had enough samples collected to determine an annual mean, even one based on just 4 quarterly samples. However, the data served as a useful screen.

Of the 37 CWSs (28.7%) having at least one sample with an atrazine concentration > the MCL of 3 ug/L, 27 were later included in the VMS and/or the ARP Surface Water Monitoring studies in which many additional samples were collected.

9.3 Texas data on atrazine concentrations in surface water source CWSs

The Texas Natural Resource Conservation Commission (TNRCC) has kept a database with the information collected by its public water systems under the Safe Drinking Water Act. Data were forwarded to EPA from TNRCC for Texas drinking water systems from 1995 to 1999. Atrazine was detected in 85 of 1,162 Texas systems with surface water as the only source of water. Only maximum values were reported. Maximum atrazine concentrations for those systems ranged from 0.11 to 10.5 parts per billion (ppb). The second, third, fourth, fifth, sixth, and seventh highest maximum atrazine concentrations were 9.60, 8.40, 5.40, 4.00, 3.10, and 3.00 ug/L, respectively.

All of the maximum atrazine concentrations were well below the Office of Drinking Water short term HALs for atrazine of 100 ug/L. Although annual mean atrazine concentrations were not provided, it is obvious that all of the CWSs with maximum atrazine concentrations < 3 ug/L could not have an annual mean atrazine concentration $\geq$ the Office of Drinking Water MCL of 3 ug/L. Furthermore, those systems with maximum atrazine concentrations only moderately greater than 3 ug/L are unlikely to have annual mean atrazine concentrations > 3 ug/L.

Atrazine was detected in only 8 of 5,500 Texas groundwater systems. Concentrations ranged from 0.18 to 3.3 ppb.

9.4 Environmental Working Group (EWG) Data

The Environmental Working Group conducted a study on atrazine concentrations in 29 cities with surface water source CWSs varying sizes across a variety of geographic areas in the U.S. Samples were collected in the same homes and offices every 3 days from May 15, 1995 through July 1, 1995 and analyzed for atrazine by bioassay.

EFED generated statistical summaries of atrazine six week mean and maximum atrazine concentrations (based upon the EWG data) are provided in Table 9-2. EFED generated cumulative exceedence tables and graphs for six week mean and maximum atrazine concentration (upon which statistical summary Table 9-2 is based) are provided in Appendix E.

The highest and 95th percentile six week mean atrazine concentrations were 8.71 and 3.77 ug/L, respectively. Six of the 29 CWSs sampled (21 %) had six week mean atrazine concentrations $\geq$ the Office of Drinking Water MCL of 3 ug/L. However, six week mean atrazine concentrations > 3 ug/L do not necessarily represent violations of the SDWA because violations occur only if the annual mean atrazine concentration exceeds the MCL. The identities of, and populations served by those CWSs can be obtained from the cumulative exceedence Table for EWG six week mean atrazine concentrations in Appendix E.

The highest and 95th percentile maximum atrazine concentrations were 18.0 and 10.4 ug/L, respectively. The highest atrazine concentration reported (18 ug/L) is well below the Office of Drinking Water short term HALs of 100 ug/L.

Table 9-1. EFED generated statistical summary of maximum and average atrazine concentrations from OHIO EPA collected data for the period May 1995 through April 1996. The percentiles are based on the percentages of CWSs with equal or lesser concentration.

Percentile	Exceedence Percentile	maximum	average
Highest	-	10.26	2.80
95%	5%	9.87	2.71
90%	10%	7.78	2.21
75%	25%	4.72	1.35
50%	50%	2.77	0.84
Total CWS. Assessed		23	24
% CWS Exp >= 3 ug/L			0.0%
% CWS Exp >= 100 ug/L		0.0%	

Atrazine MCL = 3 ug/L

Atrazine short term HAL = 100 ug/L

Table 9-2. EFED generated statistical summary of maximum and average atrazine concentrations from EWG Report - Weed Killers by the Glass. The percentiles are based on the percentage of of CWSs with equal or lesser concentration.

	Exceedence	CWS based		
Percentile	Percentile	maximum		average
Highest	-	18.00		8.71
95%	5%	10.40		3.77
90%	10%	9.20		3.54
75%	25%	6.55		2.75
50%	50%	2.90		1.49
Total CWS. Assessed		29		29
CWS Exp >= 3 ug/L				6
% CWS Exp >= 3 ug/L				21%
Atrazine MCL = 3 ug/L				
Atrazine short term HAL = 100 ug/L				

10. Conclusions and Summary of Results

10.1) Atrazine concentrations in the PLEX and comparison to Office of Drinking Water MCL and short term HALs for atrazine

Of the 21,241 ground, surface, and blend water source CWSs in 21 states with atrazine data in the PLEX database through 1998, 2,386 CWSs (11.2%) had one or more atrazine detections above limits of quantification (LOQs) (Table 4-2 which is Table 4.2-3 of MRID 450587-04). Of a total of 88,766 samples in the database, 8,685 (9.8%) had detections above the LOQs (Table 4-2). The LOQs varied from 0.01 to 0.5 ug/L, but were typically at 0.1 ug/L (Table 4-3 which is Table 3.2-6 of MRID 450587-04).

The population and % of the assessed population served by 1998, 1997, 1996, 1995, 1994, and 1993 annual mean atrazine concentrations ≥ 3 ug/L were 16,000 people (0.02%), 129,000 people (0.18%), 156,000 people (0.19%), 506,000 people (0.79%), 331,000 people (0.58%), and (76,500 people (0.17%), respectively. The assessed populations for 1998, 1997, 1996, 1995, 1994, and 1993 were approximately 79.9, 71.6, 82.3, 64.0, 57.1, and 45.0 million, respectively.

The # of CWSs and % of the assessed CWSs with 1998, 1997, 1996, 1995, 1994, and 1993 annual mean atrazine concentrations ≥ 3 ug/L were 4 CWSs (0.05%), 26 CWSs (0.31%), 73 CWSs (0.92%), 11 CWSs (0.14%), 95 CWSs 1.49%), and 19 CWSs (0.49%), respectively.
The # of assessed CWSs in those years were 8548, 8300, 7944, 7909, 6395, and 3913 CWSs, respectively.

Of the 21,241 CWSs with atrazine data in the PLEX database, 182 CWSs had one or more annual mean atrazine concentrations ≥ the MCL of 3 ug/L during the 1993-1998 period (Tables 4-1 and 4-2). Of those 182 CWSs, 81 are suppliers and 101 are purchasers. Of the 81 suppliers, 74, 5, and 2 have surface water, blend, and ground water sources, respectively. Of the 81 suppliers, 33 are in Illinois, 16 are in Missouri, 12 are in Kansas, 12 are in Ohio, 4 are in Kentucky, 2 are in Indiana, and one each are in North Carolina and Texas (Table 4-2).

The highest atrazine concentration (42 ug/L) reported in the PLEX database from 1993 through 1998 is well below the Office of Drinking Water short term HALs for atrazine of 100 ug/L. However, because only one sample was collected per quarter/CWS in the PLEX database, reported maximum atrazine concentrations in the PLEX database may often be substantially less than actual peak concentrations. Because the VMS (on 100 surface water source CWSs) and the ARP surface water monitoring study (on 175 surface water source CWSs) have substantially more time series data than the PLEX database, observed maximum atrazine concentrations in those studies for a given CWS should generally be closer to actual peak atrazine concentrations in the CWS than observed maximum atrazine concentrations for the same CWS in the PLEX database. However, the maximum reported atrazine concentrations in those studies (63.5 and 49.5 ug/L) were still well below the Office of Drinking Water short term HALs for atrazine of 100 ug/L.

10.2) Atrazine concentrations in the Rural Well Survey and comparison to Office of Drinking Water MCL and short term HALs for atrazine

In the Rural Well Survey from September 1992 to March 1995, one sample was collected from each of 1505 wells and analyzed for atrazine, and various chloro-triazine and hydroxytriazine degradates. The maximum, 99th percentile, and 95th percentile atrazine concentrations were 12.0, 2.4, and 0.87 ug/L.

Eight wells (out of the 1,505 wells sampled in the Rural Well Survey) had atrazine concentrations exceeding the MCL of 3 ug/L. Because only one sample was collected from each well, it is not known how many if any of those 8 wells had annual mean atrazine concentrations exceeding 3 ug/L. In the ARP ground water monitoring of 177 wells from May 1995 to March 1998, 2 of the 177 wells had a maximum annual mean atrazine concentration (14.3 and 4.97 ug/L based on running annual means) > 3 ug/L.

The highest atrazine concentration detected in the Rural Well Survey (12 ug/L) was much less than the short term HAL of 100 ug/L. However, because only one sample was collected per well in the Rural well Survey, the reported maximum atrazine concentration in the Rural Well Survey may be substantially less than the actual peak concentration. In the ARP ground water monitoring study of only 177 wells, but which included 12 samples/well/year over a 3 year period, one well had a maximum atrazine concentration (132 ug/L) greater than the short term HAL of 100 ug/L. However, the next highest atrazine concentration (11.0 ug/L) was well below the HAL.

10.3) Regression estimated, annual mean and annual maximum total chloro-triazine concentrations in the surface water portion of the PLEX database and comparison to HED sub-chronic/chronic and acute DWLOCs.

The regression estimated, highest annual mean total chloro-triazine concentration (17 ug/L) for surface water source CWSs in the PLEX database from 1993 through 1998 is slightly below the sub-chronic/chronic HED DWLOC of 18 ug/L for children and infants and well below the sub-chronic/chronic HED DWLOC of 63 ug/L for adults.

The assessed populations in the surface water portion of the Novartis PLEX database for 1998, 1997, 1996, 1995, 1994, and 1993 were approximately 44.0, 38.2, 41.5, 31.4, 24.0, and 23.9 million, respectively. The # of assessed surface water source CWSs in those years were 2494, 2132, 2547, 1699, 1700, and 1212, respectively.

The regression estimated, highest total chloro-triazine concentration (59.8 ug/L) for surface water source CWSsin the PLEX database from 1993 through 1998 is well below the single HED acute DWLOC of 298 ug/L (for pregnant women).

In the PLEX database of atrazine data (collected to comply with the monitoring requirements of the SDWA), the annual maximum reported atrazine concentration for a CWS also represents its annual maximum reported 3-month quarterly mean because only one sample is generally collected per quarter (3 months). Therefore, the EFED compared regression estimated annual maximum total chloro-triazine concentrations to HED chronic as well as acute DWLOCs. The actual annual maximum quarterly mean for a CWS may be lower or higher than the annual maximum reported atrazine concentration for the CWS.

The population and the % of the assessed population served by estimated 1998, 1997, 1996, 1995, 1994, and 1993 annual maximum total chloro-triazine concentrations $\geq$ the HED sub-chronic/chronic DWLOC of 18 ug/L for children and infants were 1450 people (0.003%), 105,721 people (0.28%), 40,586 people (0.10%), 0 people (0.0%), 210,544 people (0.84%), and 184,092 people (0.77%), respectively. The assessed populations in the surface water portion of the Novartis PLEX database for 1998, 1997, 1996, 1995, 1994, and 1993 were approximately 44.0, 38.2, 41.5, 31.4, 24.0, and 23.9 million, respectively.

The # of CWSs and % of the assessed CWSs with 1998, 1997, 1996, 1995, 1994, and 1993 annual maximum total chloro-triazine concentrations $\geq$ the HED sub-chronic/chronic DWLOC of 18 ug/L for children and infants were 2 CWSs (0.08%), 9 CWSs (0.42%), 19 CWSs (0.75%), 0 CWSs (0.0%), 30 CWSs (1.77%), and 3 CWSs (0.25%), respectively. The # of assessed surface water source CWSs in those years were 2494, 2132, 2547, 1699, 1700, and 1212 CWSs, respectively.

The identities of, and populations served by CWSs with annual maximum total chloro-triazine concentrations $\geq$ the HED sub-chronic/chronic DWLOC of 18 ug/L for children and infants can be obtained from the cumulative exceedence tables in Sub-Appendix A-5.

The regression estimated, highest annual maximum total chloro-triazine concentration (59.8 ug/L) for surface water source CWSs in the PLEX database from 1993 through 1998 was slightly below the HED sub-chronic/chronic DWLOC of 63 ug/L for adults.

10.4) Comparison of total chloro-triazine and total hydroxy-triazine concentrations in the Rural Well Survey to HED DWLOCs

One well (out of 1505 sampled in the Rural Well Survey) had a total chloro-triazine concentration equaling the HED sub-chronic/chronic DWLOC of 18 ug/L for the chronic exposure of children and infants, respectively. No wells had total chloro-triazine concentrations exceeding the HED sub-chronic/chronic DWLOC of 18 ug/L for children and infants, the HED sub-chronic/chronic DWLOC of 63 ug/L for adults or the single HED acute DWLOC of 298 ug/L for adult women.

The highest total hydroxy-triazine concentration detected (7.66 ug/L) was much less than the HED chronic DWLOC of 99 ug/L for children and infants.

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